

DEC 15 1949

# AGRICULTURAL ENGINEERING

DECEMBER • 1949

Farm Structures—A Forward Look for Agricultural Engineers

*Henry Giese*

A Conveyor-Belt Gutter Cleaner Developed by Engineers

*D. C. Sprague, A. S. Mowery*

Some Recent Results of Milking Parlor Research Work

*J. W. Wilkins*

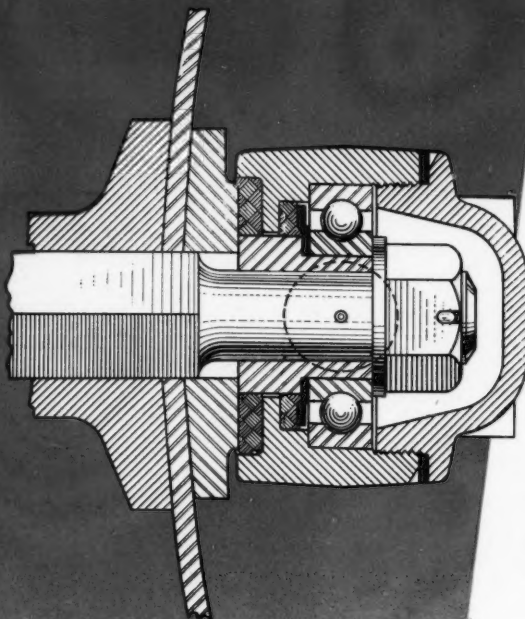
Some Fire Safety Aspects for Crop Drying Equipment

*L. G. Keeney*

Measuring Soil Moisture by Electrical Resistance

*G. J. Bouyoucos, G. A. Crabb, Jr.*





● For a real problem in applied mechanics, just try to analyze the forces tending to cause, and to resist rotation of a disk harrow blade, and to arrive at its resultant rates of rotation, at various angles and depths of operation. You may be surprised, at the greater angles and depths, to learn how little the rotational forces exceed the retarding forces.

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In terms of timeliness and tilth, the "CO" promotes high yields per acre. This, plus savings in man-hours, helps to achieve the thing that counts in modern agriculture — high yield per man. J. I. CASE Co., Racine, Wis.

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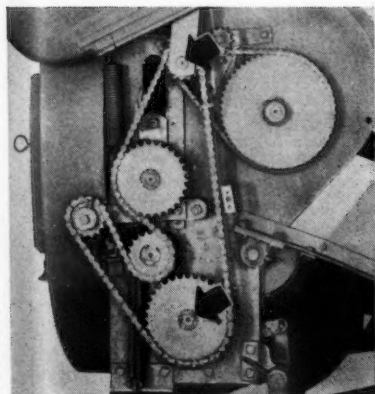
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## help John Deere Forage Harvester

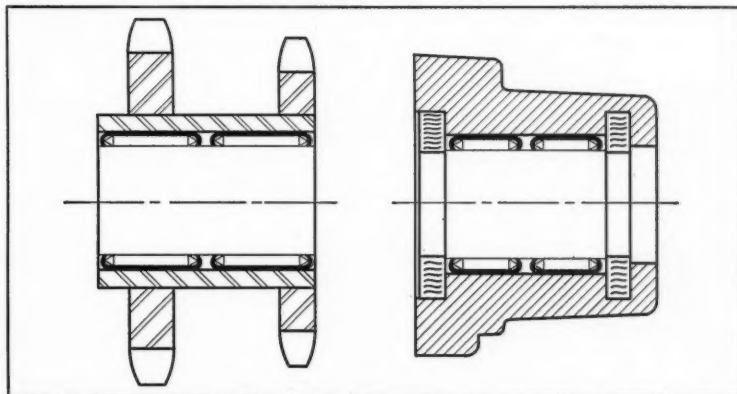
### run smoother, last longer



The John Deere Forage Harvester chops and loads green or field cured hay, straw, or row crops for silage, in a steady, uninterrupted stream. To keep feed rolls running smoothly with minimum wear, Torrington Needle Bearings are used on feed roll drive shaft and sprocket.



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# AGRICULTURAL ENGINEERING

Established 1920

## CONTENTS FOR DECEMBER, 1949

Vol. 30, No. 12

EDITORIAL .....	563
FARM STRUCTURES—A FORWARD LOOK .....	565
<i>By Henry Giese</i>	
DEVELOPING A CONVEYOR-BELT GUTTER CLEANER .....	569
<i>By D. C. Sprague and A. S. Mowery</i>	
VERMICULITE INSULATING CONCRETE IN ANIMAL SHELTERS .....	572
<i>By Harvey W. Steiff</i>	
SOME RESULTS OF MILKING PARLOR RESEARCH .....	573
<i>By J. W. Wilkins</i>	
FIRE SAFETY ASPECTS OF CROP DRYING EQUIPMENT .....	579
<i>By L. G. Keeney</i>	
MEASUREMENT OF SOIL MOISTURE BY THE ELECTRICAL RESISTANCE METHOD .....	581
<i>By G. J. Bouyoucos and G. A. Crabb, Jr.</i>	
A MODIFIED VENTURI SECTION FOR MEASURING IRRIGATION WATER IN OPEN CHANNELS .....	584
<i>By J. E. Ferguson and J. E. Garton</i>	
GRAIN VALUES TO BE SAFEGUARDED DURING CONDITIONING AND STORAGE .....	586
<i>By K. S. Quisenberry</i>	
IMPROVED ROLLING COULTER DESIGN .....	588
<i>By J. W. Martin</i>	
RESEARCH NOTES .....	590
NEWS SECTION .....	592
PERSONNEL SERVICE BULLETIN .....	602

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# EDITORIAL

## Work for Agricultural Engineers

**M**EMBERS of the American Society of Agricultural Engineers are employed in a surprisingly wide range of activities. From one viewpoint as to significance these can be grouped as follows:

1 Recognized and typical agricultural engineering work in which the value of agricultural engineering technology has been substantially proven.

2 Higher executive and administrative positions achieved following and as a result of successful experience in agricultural engineering, or in related fields of agriculture or engineering.

3 Work in new fields in which the individual agricultural engineer sees an undeveloped opportunity for the effective application of agricultural engineering training and experience.

4 Temporary work taken on as a source of income pending location of a more suitable opportunity to apply agricultural engineering training and experience.

We are particularly intrigued by activities in the first three of the above categories, in which not only the individual but the value of agricultural engineering training, experience, and technology are definitely on trial with a specific employer or a class of employers. The extent to which they make good will have a strong influence on future developments and opportunities in agricultural engineering. The very knowledge that some members are engaged in these activities may help others to find or create new opportunities for professional progress.

A substantial number of members are employed in trade associations and individual companies in the engineering materials industries. The industries thus represented and interested in improving their service to farmers include aluminum, copper, brass, bronze, lead, nickel, steel and zinc in the metals group, and asbestos, brick, limestone, glass, gypsum, petroleum, portland cement, tile, and vermiculite as well. The lumber, fiber, paints and coatings, and chemical industries can also be included in this group. Others may show up in the future.

The farm equipment industry is a natural place for their employment, in which agricultural engineers have proven their ability and earned increasing acceptance over a period of years. Still there are quite a number of the smaller manufacturers who employ no agricultural engineers, or not enough of them to do their job. They include manufacturers of prime movers, small tractors, tillage equipment, pumps, irrigation equipment, harvesting and handling equipment, crop driers, prefabricated buildings and bins, pest control equipment, refrigerators, barn equipment, fans and blowers, and miscellaneous specialized items.

In the component parts classification, leading manufacturers of bearings, chain, tires, and wheels have members keeping a watchful eye on progress in the agricultural engineering field, and contributing to that progress.

A token representation from the electrical manufacturing industry is doing the same.

Of more than 70 public utilities having agricultural engineers helping them serve their farm customers, more than half have only one each, and most of the rest have only two, three, or four, but three utilities have found it desirable to have ten or more.

A score of the hundreds of farm electric cooperatives have found it desirable to use agricultural engineers to manage or assist in managing their operations.

One of the proven opportunities for an agricultural engineer to get started in a substantial small business of his own, or to work into a partnership, is in the distribution of farm equipment, building materials, and related items. Somewhere around one hundred ASAE members are owners, partners or employees in this type of business, and doing well at it. This is just enough to emphasize the need and opportunity for agricultural engineers in thousands of similar establishments.

Other lines of work and types of employment in private

enterprise in which individual ASAE members have been successful, and have proven the value of their engineering training, add to the variety of opportunities for new employment and progress. They include farming, agricultural engineering work for large farms and for processors of farm products, management of individual farms, and of groups of farms on a consulting basis, consulting work on agriculture and engineering, the farm and trade press, trade associations, farm organizations, general contracting, and farm work and soil conservation contracting.

In public service, agricultural engineers are employed in a variety of agencies in addition to those directly concerned with teaching, extension and research. Two ASAE members are employed by the United Nations.

In the federal government there are ASAE members employed in the Bureau of Public Roads and Bureau of the Census of the Department of Commerce; in the Geological Survey and Bureau of Indian Affairs, as well as the Bureau of Reclamation, Department of the Interior; in the State Department Institute of Inter-American Affairs; in the land, sea, and air branches of the Department of Defense; and in the Federal Land Banks, Public Health Service, Veterans' Administration, Federal Power Commission, Office of Education, and War Production Board, in addition to those in the Department of Agriculture. And within the Department of Agriculture, ASAE members are employed by the Farm Security Administration, Forest Products Laboratory, Office of Foreign Agricultural Relations, Office of Personnel, Weather Bureau, Regional Research Laboratories, and Farm Credit Administration, in addition to those in the SCS, BPISAE, Extension Service, and the Office of Experiment Stations.

Among extra-governmental activities, the TVA is an established employer of agricultural engineers, and the Lower Colorado River Authority has already employed at least one.

In some of the states and territories agricultural engineers are employed in agencies concerned with natural resources and with public health, and in state schools, as well as in the land-grant colleges and experiment stations and the extension service.

In still more localized public service agricultural engineers are employed by some county engineering departments and by irrigation, drainage, and soil conservation districts. It appears that these agencies may justify and develop a considerably increased demand for agricultural engineering services.

In Canada, the dominion government and the provinces employ agricultural engineers on a comparable basis in proportion to the extent of their agriculture.

On other continents demand for agricultural engineering services has shown up in civilizations as old as those of China and Egypt; in governments as new as those of Israel, India, and Pakistan; and in regions as undeveloped as the Amazon River Valley.

The capacities in which ASAE members are employed range from trainees to presidents and chairmen of the boards of large corporations, corresponding high administrative posts in public service, and ownership of businesses of various sizes.

It seems to us that the basis of all of this present and potential opportunity for agricultural engineers lies in one significant fact. It is impossible to give intelligent consideration to any major phase, aspect, problem, or operation of agriculture without including consideration of its related physical factors. These physical factors—the environment of men, animals, and crops; the energies, dimensions, and operations involved; the very physical structure and properties of biologic materials—are the field in which engineering has proven the most effective technology and agricultural engineering the most effective specialization of that technology on behalf of agriculture. Opportunities for agricultural engineers will increase as recognition of this fact becomes widespread, and as agricultural engineers continue to add to their established record of service.

# What the Agricultural Engineer, Rural Builder and Farmer Should Know About Douglas Fir Plywood

The proper selection of building materials for the farm is based on a number of considerations.

This is one of a series\* describing these considerations as they apply to the selection and use of Douglas fir plywood for rural homes and farm buildings.

## SIDING WITH EXTERIOR PLYWOOD

A WIDE variety of siding effects is made possible by the large panel sizes of Exterior-type Douglas fir plywood—the type bonded with completely waterproof adhesive for permanent outdoor applications. Large panel sizes, too, contribute to ease of handling and speed of application.

PlyShield is the siding grade of Exterior-type Douglas fir plywood—a panel with one face of high appearance quality, suitable for painting and fine finishing. PlyShield would be specified for siding homes and other structures where appearance is of prime consideration. Other grades of Exterior plywood are suited to many farm siding requirements. Exterior Utility grade, for example, would be specified for barns and other buildings where appearance is of secondary importance. In many farm uses, where appearance value is of no importance, Exterior Sheathing grade would be entirely satisfactory. All these grades, of course, have the Exterior-type completely waterproof bond. Most popular size is the 4x8-foot panel, although other standard lengths and widths are available.

Possible siding treatments range from simple lapped siding and board and batten to wide siding and flush surface. PlyShield applied horizontally or vertically using molded battens, vee-grooves or flush joints makes possible stimulating, modern exteriors. As well, PlyShield, applied in half-panel or third-panel widths, is excellent as wide siding for traditional and modified designs.

Or PlyShield is used to advantage to complement other building materials with the plywood utilized for gable ends, entrance treatments, paneling above or below windows, for an upper or lower band on walls, and for dormers and bays. PlyShield is the preferred material, too, for horizontal surfaces such as soffits, porch ceilings and breezeway ceilings.

### Joints

In siding with Exterior Douglas fir plywood, there are several simple and attractive alternates for handling joints between the panels. Suggested treatments for both horizontal and vertical joints as well as

water table details are shown at right. All edges of plywood siding—no matter whether butted, veed, covered or exposed—should be bedded in a thick lead and oil paste or other suitable compound. This is knifed on as panels are installed. F.H.A. specification for the “bedding” or “filler” is: 100 lbs. of paste white lead, 1¼ gals. raw linseed oil and 1 pint of dryer. Dryer may be reduced to ½ pint if boiled linseed oil is used. If plywood is installed as lapped siding, it is recommended the lap be at least 2" and bedded in paste. The vertical butt joint between pieces of plywood used as lap siding may be protected by a strip of asphalt-impregnated building paper tacked (immediately behind siding) to stud on which the butt joint will occur. This will act as flashing. Also, horizontal edges should be beveled slightly so water drips from outside edge.

### Finishing Procedures

For greatest weatherability and best appearance, farm structures of Exterior ply-

wood should be painted. Other conventional farm finishes—barn paints, whitewash, etc.—may be adequate for many farm uses. Even if the plywood structure is left unpainted, it will remain structurally sound and tight if edge-sealing instructions detailed above are followed carefully during construction.

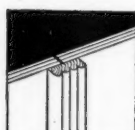
For painting exterior surfaces, the three-coat system is suggested as providing the best conventional protective coating.

The initial or prime coat is most important! A high grade exterior primer, thinned with one quart of pure raw linseed oil per gallon of paint and brushed on is recommended.

Over the primer, apply the second and third paint coats according to paint manufacturer's directions.

All edges of plywood should be sealed with white lead and oil paste applied during construction. Also, in unusually damp localities, the panels should be back-primed during construction. Plywood, including any exposed edges, should be primed as soon as possible after erection.

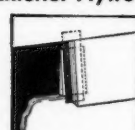
### Joint Suggestions for Exterior Plywood



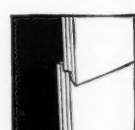
With Molded Batten



Vee Joint



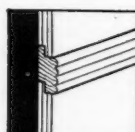
Vertical Joint Butted—  
Horizontal Joint Lapped



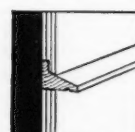
Horizontal Joint Double  
Shiplapped—Vertical  
Joint, Shiplapped



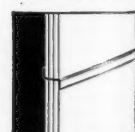
Shiplapped



Shiplapped Molding



Wood Water table



Metal Flashing

**Douglas Fir**

**Plywood**

\*Other subjects: Plywood Availability; Types and Grades; Unit Stress Values; Structural Strength Characteristics; How to Panel Wall Surfaces; Application Methods for Exterior Plywood. Reprints may be secured by writing Douglas Fir Plywood Association, office nearest you: Tacoma Bldg., Tacoma 2, Wash.; 848 Daily News Building, Chicago 6, Ill.; 1232 Shoreham Building, Washington 5, D. C.; 500 Fifth Ave., New York City 18.

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# AGRICULTURAL ENGINEERING

VOL. 30

DECEMBER, 1949

No. 12

## Farm Structures—A Forward Look

By Henry Giese

FELLOW A.S.A.E.

THE enviable position which the American farmer has achieved among the farmers of the world has been due to a large extent to the application of engineering principles to his operation. Others may excel him in production per acre, but his large output per worker has elevated him from peasant status and given him a relatively high economic and social position. If he is to have and maintain equitable status with workers in other industries, however, it will be necessary for him to be constantly on the alert for still further improvement. The possibilities of food surpluses with lowered prices will demand decreases in operating costs to maintain satisfactory profit margins. If, on the other hand, population increases result in a larger demand for food, it will be highly desirable to increase further the production per worker.

Food, shelter and clothing are considered to be the basic necessities for human existence. Feed and shelter are necessary for the successful raising of animals in the temperate climates. Shelter is indispensable in the holding of crops either for consumption on the farm or for orderly marketing. The agricultural engineer has a real opportunity to be of eminent service to American agriculture by further developments in industrializing his farming operations.

In considering the possibilities, however, we must not overlook the fact that the price per production unit may be only a poor measure of actual production costs. Cheap equipment does not necessarily mean cheap production, but on the other hand may often result in very expensive production. Dr. J. B. Davidson, recently returned from an extended assignment in China, tells us that a full set of farm tools as used by many Chinese farmers might be purchased for approximately \$10 in the United States. Much Chinese plowing is done with a swing fork. This is a cheap implement when measured in its original cost. With it, however, it takes 24 days for a man

to plow an acre of ground. We have often heard that a Chinese coolie receives only a bare existence for his work, but freight moved in this manner costs 15 times as much per ton mile as when hauled by our expensive American railroads.

We could use a number of other illustrations. One of these is hybrid seed corn. In spite of the fact that a farmer could go to his crib and select ears as he did years ago we find that practically all of the corn raised in the corn belt is from high-priced hybrid seed. The increase in yields far more than outweighs the extra cost of seed. Years ago there were some who told us that the horse provided the cheapest form of farm power. He could be produced on the farm and consumed feed also raised on the farm. Notwithstanding these advantages, however, the number of horses on farms has dwindled very rapidly and the tractor is taking over as the farm power unit. We might again ask the question, if a farmer is looking for cheap harvesting equipment, where could he find anything which costs less than a sickle and a flail, which are still the principal tools of harvesting in many countries? American farmers discarded these implements long ago in favor of the much higher-priced binder and thresher, and still more recently the combine. The answer is simple. The more expensive equipment is so much more efficient that production is actually cheaper when it is used. The farmer must consider his over-all cost and not simply the purchase price of what he is buying.

The great advance in mechanization of agricultural operation has not been matched by similar improvements in buildings. We are advised that nearly 50 per cent of a farmer's time is spent in and around his buildings. This percentage, of course, becomes higher if the time required for field operations is greatly reduced while that in the buildings remains approximately the same as it was years ago. Any attempt toward improvement in the performance of buildings should provide a great challenge to agricultural engineers. Not only may the building affect the labor efficiency on the farm, but it may have a considerable influence on production of products such as milk or eggs, both in quality and quantity, in the preservation of stored products, and also on the quality of tenant

This is an address delivered at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949.

HENRY GIESE is professor of agricultural engineering, Iowa State College, Ames



One important problem confronting agricultural engineers concerned with improving farm structures is the handling, processing, and storage of grain and hay. Many present structures are inadequate for that purpose. Storages that served well before mechanization speeded up harvesting are not satisfactory now. There is great need for agricultural engineers to strive for improved structural performance

which an absentee owner may secure to operate his land. What is then to be our measuring stick for buildings? Does the farmer want cheap buildings or cheap production? Can the American farmer afford poor housing?

Some years ago Philip S. Rose, then editor of *Country Gentleman*, stated that the great challenge in agriculture was the elimination of drudgery on the farm. We should make this one of our first objectives in the field of structures. City luxury as compared to farm drudgery has been perhaps one of the most important factors tending to lure farm young people away to the city. The elimination of drudgery may mean actual labor saving with implied shortening of time or labor easing. Making a chore lighter is a real contribution even though the time consumed is not reduced. I can remember the time when riding a cultivator was considered to be evidence of a lazy farmer. It was necessary for a man to walk behind his plow to prove that he had the stuff. When one farmer added a sun shade he was the laughing stock of the entire community. We look at things differently now.

We should strive to improve the many items in buildings which will contribute materially to the raising of living standards. The elimination of rural slums and the making of living more enjoyable on the farm will be a very large factor in keeping the highest quality of people there.

The third challenge facing agricultural engineers is the lowering of production costs. We are this year facing a serious problem in corn storage. Many cheap storages have proven to be very expensive because the corn did not dry to the extent that it would keep after being put in the storage, and hence deteriorated materially. Very frequently the loss through inadequate storage in one year will pay the entire cost of a satisfactory crib. Buildings can lower production costs if they do the job better, making it possible to produce more or to save more of stored products which can be marketed at a satisfactory price rather than at a severe discount.

#### LASTING LONGER BUILDINGS LOWER COSTS

Buildings can lower production costs if they last longer. Years ago Wooley and Johnson of the University of Missouri found that a barn which would then cost  $3\frac{1}{2}$ c per cu ft might be expected to last 28 yr while one costing 4c per cu ft would last 45 yr. A 60 per cent increase in length of life would be obtained from a 14 per cent increase in cost. Usually however, it might represent an increase in cost of less than 14 per cent to secure a structurally satisfactory building. Structural improvement is more a matter of a knowledge of materials and structures than the addition of extra materials or labor. Buildings will last longer also if the waste from wind, fire and destructive elements can be reduced. These wastes usually occur from a lack of knowledge of materials for specified purposes or their best use in a building.

*The Farm Structures Field.* The farm structures field is broad and involves many considerations. Some farm owners get a great deal of personal satisfaction from buildings which are of higher quality than would be required for efficient farm operation. We would have no quarrel with these people any more than we would with the man who purchases a relatively high-priced car when a lower priced one would do the job satisfactorily for him. On the whole, however, we believe that the justification of buildings on a farm is their economic value to it. This economic value may sometimes prove rather elusive and difficult to measure. It is scarcely conceivable in most portions of the country that it would be possible to farm successfully without buildings. The question then is not whether to build, but how. How can we lower the first cost of the structure without impairing its performance or increasing the upkeep to a greater extent than its cost is lowered? Buildings represent a relatively small fraction of the operating cost of a farm. The possibility of lowering this fraction does not present a very profitable undertaking if the total cost of production must be reduced. On the other hand, the failure to build most effectively may increase some of the other cost-factors more than the total cost of the use of the building.

We must not overlook the social aspects of housing. It is



A good example of a modern (Rilco) machine shed on the farm of Peters Brothers near Brownton, Minn.

not difficult to understand why the owner operator usually has better buildings than the absentee owner. Are there equal benefits on rented farms? An absentee owner cannot afford to have a poor tenant on his farm but can well afford to improve his buildings to the extent necessary to secure and keep a high-class tenant.

The agricultural engineer must know the demands placed upon a building by the animals or crops housed in it. We have heard much in recent years about the necessity for determining the functional requirements. One of the first activities in the farm structures program under the Federal Research and Marketing Act was an attempt to find what farmers need and want in farm houses. After many centuries of housing we still seem to lack specific statements regarding what should be provided in a farm house. Along with this are the requirements for housing animals. What are their physiological reactions to adverse environmental conditions? Can we state with certainty the influence which the various elements in the barn have upon sanitary milk production? Failure to house cows properly may result in some economic loss due to lower production, but failure to observe sanitary requirements constitutes a serious menace to human health. Likewise, what conditions are necessary for the proper conditioning of grains in storage in order to avoid serious losses and perhaps to raise them to a better marketable condition?

In addition to functional requirements, however, we should give attention to structural improvements. The ability of a structure to resist internal pressures such as those from stored grains or external pressures from wind or snow may have much to do with its length of successful life.

A designer must also know a great deal about materials. We have as yet no universal building material. Even the smaller buildings require the use of several. All materials which have been in common use for some time have properties which continue to make them desirable. All likewise have some limitations. It is just as necessary to know what a material will not do as it is to know its merits. It is likewise desirable to know whether several materials will do a certain job equally well. One must be versed in the common structural techniques. Very frequently the failure to use materials in their standard sizes results in an unnecessary increase in the cost of a building. Experience has shown us that materials go together better in certain ways than they do in others. On the other hand, while being versed in the common construction techniques, the agricultural engineers should not be hampered by tradition if material improvement can be made by some departure from it.

The fifth item concerning farm structures deals with design. This comes as a final step, after the designer has familiarized himself with the other four items mentioned. If a building is designed properly, it must meet the functional requirements of the humans, animals or crops to be housed. It must be structurally sound, involving a correct utilization of building materials. It should provide for economy of labor and materials in the construction and labor efficiency in operation. It should be attractive in appearance.

*Problems.* In spite of the fact that when one reviews national figures, he is impressed with the size of the figures regarding investment in farm buildings, he may gather the impression on a field trip that the job has been poorly done. Quite

like the farmer who was not interested in going to hear the extension man talk because he said he was not farming as well as he knew how, we find a great challenge because farm buildings generally are far behind even present knowledge. Perhaps it would be well to review a few reasons for this situation. We must admit at the outset that there is a serious lack of facts. The amount of basic research has been limited, considering the magnitude of the problem involved. All too often the best advice that we can give is based on personal opinion, which may or may not be accepted by the man who has to pay the bill.

Farm building problems are complicated. Building is not a job which the farmer does every day or every season, but at rather widely spread intervals. He needs help. He cannot do his own research because his enterprise is too small to carry the load. Farm business generally is not profitable to the professional architect, with the result that he has not trained himself for it. Nor is the farmer to date convinced that the money which he would spend for an architect's fee is justified. The contractor in the usual sense is frequently not present. Much farm building is done with farm labor and most of the remainder by country carpenters who must be jacks-of-all-trades. We do not have the large-scale builders which have on their staffs men specializing in the various phases of construction work.

In few states, if any, are there building codes which regulate the manner in which a farmer builds. Building codes are primarily to protect community interests. It is perhaps, within a man's right to make mistakes if no one suffers but himself.

Buildings are still assembled on the farm from materials purchased, in some cases, from different dealers. Prefabrication has not yet come into common use, especially in the larger structures. Economies in fabrication on a large scale may be offset by increased transportation cost. It is improbable that prefabrication will go much beyond the possible precutting of materials in the local lumber yards, or the prefabrication of parts in the factory. This is quite in contrast with mechanical farm equipment which comes to him fabricated, assembled and ready for use.

The help from manufacturers is limited. Since there is no universal building material and no manufacturer which makes everything necessary to construct a building, it is only to be expected that the manufacturer will be somewhat hesitant in selling his competitor's materials. He is then very likely to limit the amount of help he will give to the farmer in his building program. There is no strictly farm material as there are definitely farm machines. Materials suitable for use in the country are equally suitable for use in town. Too often the manufacturer may overlook the fact that while city construction is under the supervision of competent persons with the result that the material is used properly, performance on the farm may be impaired, on the other hand, because of poor usage. A few manufacturers or associations of manufacturers, notably the Portland Cement Association, have faced this problem squarely and have done a very fine job of consumer education. It is to be hoped that others will follow this pattern

to reduce improper usage which results in the unsatisfactory performance of their materials.

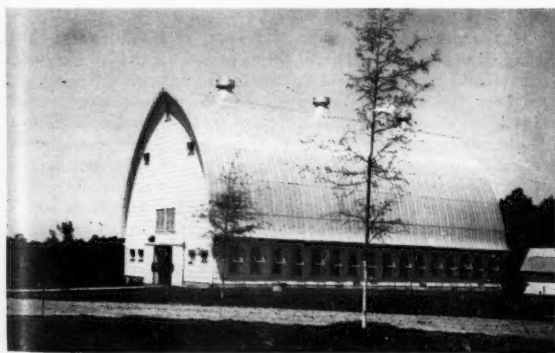
Buildings may suffer also because of a lack of appreciation of the problems involved. Performance standards are not fixed, due perhaps primarily to a lack of tangible measures of what constitutes good performance. One can, for example, determine rather quickly whether a plow or a combine is doing its job well. He can measure not only the quality of the job being done but also the energy required to do it. Certain adjustments can be made which will bring the performance standard desired by the manufacturer and the owner. How would one thus measure the performance of a dairy barn? We do not have adequate measures of the penalties which one pays for poor performance.

There are also problems related to ownership and tenancy. Many of our farms are absentee owned. Under the prevailing systems of rentals, the man who pays for the improvements may not profit from them directly and may not have the foresight to consider his indirect benefits. Farms are owned by individuals usually and not by corporations which go on indefinitely. The relative short term of ownership can cause the adoption of a short-range attitude and to the mining out of a farm's resources rather than maintaining them on a long-time basis. The general tendency of a tenant to be careless of another man's property often discourages an absentee owner from doing what he should. An increase in investment may mean simply still further expenditure for upkeep and taxes. While the agricultural engineer may have little or no control over these limiting factors, the knowledge of them may be beneficial to him and influence him in his thought and action.

#### MIDWEST PLAN SERVICE TAKES THE LEAD

*Progress.* While we may become discouraged at times because of the difficulties encountered in securing adequate support for our efforts and the burden of many tasks which retard our scientific growth, we should take some satisfaction in the acceleration which has taken place in recent years. One of the most outstanding developments has been the tendency toward cooperation. The first extensive effort in this direction was perhaps the Midwest Plan Service, which had a very modest and unofficial origin some 20 years ago, under the wing of the Farm Structures Division of the American Society of Agricultural Engineers. Started by a small group, the extent of cooperation among states increased until in 1935, when the first catalog was issued, some 15 land-grant colleges and the U. S. Department of Agriculture were listed as participating. A few years later this type of activity spread to the northeast, the southern and the western states, so that now we have four regional farm building plan services. The Midwest Plan Service has now attained official status and is operating under a memorandum of understanding signed by the directors both of the experiment stations and extension services in the north central region.

Another forward step in cooperation was effected early in 1944 when directors of the state agricultural experiment stations in the north central region authorized representatives from the various departments interested in the several aspects of farm housing to meet in Chicago to attempt to state the problems involved, outline research which should be undertaken, and to set up an organization which would function on a regional basis. Subcommittees were formed as follows: The farm house, dairy cattle housing, swine housing, poultry housing, beef cattle and sheep housing, grain storage, forage crop storage, fruit and vegetable storage, machinery storage and farm shop, farmstead planning, economic relationships, utilization of building materials, and the Midwest Plan Service. Committee chairmen were chosen primarily on the basis of specialty of the worker, but also with a view of spreading the responsibility so that no person would have more than one committee chairmanship. Personnel of the several subcommittees were chosen by the chairmen to represent not only knowledge of the various regional aspects of the problems involved but also specialists in fields other than agricultural engineering. The organization of the committees included also a steering committee which could act between meetings of the re-



This 36 x 68-ft Rilco barn is on Brookberry Farm near Winston-Salem, N. C.

gional committees. Activities of the committees included the listing of projects for research and the preparation of publications representing the best current thinking. Three regional bulletins have been issued. In general, it is the policy for the state in which the chairman is located to issue the bulletin, but to credit it to regional cooperation. Each bulletin carries a regional and state number. The first bulletin, entitled "Beef Cattle Housing in the North Central Region of the United States", was published in South Dakota due to the fact that the late Ralph L. Patty was chairman of the beef cattle subcommittee. The second publication, "Dairy Cattle Housing in the North Central States," was issued as a Wisconsin bulletin under the supervision of Stanley A. Witzel. The third, "When You Build or Remodel Your Farm House," was published by the University of Illinois, and under the direction of Deane G. Carter, chairman of the farm house subcommittee. Other manuscripts are now in preparation.

It is believed that cooperation among the several states tends to bring the workers much closer together and to give each one the benefit of the thinking by the others in the group. It tends also toward a greater uniformity of recommendation by the agricultural engineers. It works for economy in the preparation of publications and greater prestige when they are issued.

The organization which had already been under way for some time proved to be especially beneficial when the passage of the Research and Marketing Act made additional funds available for farm structures research. This act has perhaps been one of the most effective means of increasing cooperative effort and in getting some meeting of the minds as to what research projects are of greatest importance. In the north central region, for example, at a meeting of the committee, all of the projects previously suggested were reviewed, consolidated or eliminated to a list of twelve. Ballots were then taken to determine which should be undertaken first. Problems relating to the farm house were given priority over all others. Three more considered to be of great importance were dairy housing, the selection and utilization of building materials, and the handling, processing, and storage of feed. Regional projects have been under way on the first three since the act became effective. It is my understanding that the farm house was considered of prime importance in the other three regions also. From the initial field study of needs and preferences authoritative information should be forthcoming soon which we have been needing for the adequate design of farm houses.

#### PROJECTS TO DETERMINE FUNDAMENTAL REQUIREMENTS

These illustrations are given only as typical of a considerable number of others. Outstanding projects are being carried on to determine the fundamental requirements for housing for farm animals. One of these is the psychoenergetic laboratory at the University of Missouri for the study of dairy cows. A similar setup is located at Davis, Calif., for the study of swine and another at Beltsville, Md., for the study of poultry. The first two are cooperative with the U. S. Department of Agriculture and the third is being conducted solely by the Department.

In general, I have attempted to discuss the importance of buildings and housing, some of the problems which must be overcome if the job is done adequately, and to give a brief review of recent progress. Perhaps the real question in the situation is "Where do we go from here?" If one sets out to travel, three things are necessary. He must have a destination if he expects to arrive. He should plan his itinerary if he wants to get there without loss of time or effort. Equally essential is the fact that he must pay the fare. These three elements are equally essential if we expect to go forward effectively in farm structures. Our ability to serve agriculture depends to a very large extent upon our skill as engineers. We must have a destination or a goal. This means the setting up of definite objectives rather than doing from day to day what seems to be the next best thing. We need to plan a program and we must be willing to put forth the effort required to carry it out.

**A Forward Look.** Research is of prime importance in the advancement of farm structures. We have still a relatively

virgin field with the horizons close in. I shall not attempt to give a complete list of the things that should be undertaken. One very important problem is the handling, processing, and storage of grain. Recent experience has shown that many of our structures are inadequate. The development of mechanized equipment has brought with it a tendency toward earlier and faster harvesting. Storages which served well under slower farm operation are not satisfactory now. This will doubtless mean a great increase in the use of artificial processes for grain and hay. The accomplishment of these things satisfactorily, economically, and free from the hazard of fire are very important problems.

Labor efficiency gives us a high goal to shoot at. Is it possible for us in our buildings and structural equipment to, in some manner at least, approach the developments which have been made in the other farming operations? Labor is a serious problem to the American farmer. We need to strive for improved structural performance. We must not overlook factors that contribute to human and animal health.

We must not only do more research, but we must give careful thought to the quality of that research. It is my belief that there has been a serious tendency for individuals to undertake projects on too broad a basis. A few things learned for sure are much better than many things maybe. A number of years ago, while making a survey of farm structures in the United States, it was observed that some 16 institutions were studying the ventilation of animal shelters. Unfortunately not one of these projects was carried out to the extent that positive and satisfactory results were obtained. The prestige of our profession would be enhanced if contributions to the literature were more limited in coverage, but more fundamental in concept.

#### COOPERATION HAS HELPED, NEEDS EXPANSION

Much advance has been made in cooperation, not only among individuals within an experiment station, but also among stations. We must expand this activity further. Our world is becoming so complicated that high specialized training is becoming more and more necessary. The individual is inadequate, and must correlate his efforts with those of others. Cooperation also means economy in the use of funds. Cooperation among stations does not necessarily mean that each is doing the same thing, but rather that the work of one station will complement or supplement that in another, so that with the pieces together we have a unified whole. A fine machine or building requires not only perfection in the several details, but also coordination of the individual elements.

Research is of little value unless the results are made available to those who need it. Failure to report research might be termed a misuse of public funds.

We need more trained specialists in structures, not only agricultural engineers who can serve in educational and industrial positions but also at the rural builder or dealer level. We need people out on the firing line who know the requirements of structures and how they should be put together to meet those requirements.

Standardization of buildings offers a real challenge to the agricultural engineer. There does not appear to be necessity for variation to suit personal taste in animal and crop storage structures. In the early days of the automobile, each owner felt that his must be slightly different from his neighbor's. We have learned, however, not only that can greater economy be effected if the cars are standardized, but also that the designs can be improved so that all are far more attractive. Likewise in buildings we can devote more individual attention to buildings which may be built in large numbers. Buildings should be standardized in their detail as well as in the completed structure. Buildings should be so designed that they may be convertible to different uses.

We need a farm structures handbook with the essential information available within two covers. We need a book of structural standards, particularly for the benefit of the younger designers, but also for greater efficiency for the more experienced ones. We need still better (Continued on page 571)

# Developing a Conveyor-Belt Gutter Cleaner

By D. C. Sprague and A. S. Mowery

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**A** WIDE variety of machines for cleaning dairy stable gutters are now available. Field observations of some of these machines and work done at the Pennsylvania Agricultural Experiment Station in the development of conveyor-belt-type equipment indicate that further effort must be made and more experience gained before "push-button" methods of cleaning stables become common.

Installation problems seem to be a definite obstacle to the general use of mechanical devices of this kind. Services required in the development of gutter cleaners are not limited to those of machine designers, metallurgists, and chemists, but also include those of farm-building and dairy-management specialists. The demand is so great that it can be considered a foregone conclusion that means which will facilitate the installation and operation of mechanical barn cleaners soon will be forthcoming.

Mechanical equipment already developed includes (1) a portable electrically-driven machine designed to load a litter carrier or manure spreader directly from the gutter as the loader moves along the gutter, (2) several devices by which the manure is pushed along the gutter and out of the barn by means of a blade or scoop attached to a tractor or pulled by an electrically-powered cable and winch, and (3) conveyors of various kinds which are in gutters and driven by electric motors. The conveyor-in-the-gutter type is the more common in Pennsylvania. This type offers the possibility of so-called push-button operation. With some of these devices, manual labor is required only for cleaning of stalls, leveling the load in the spreader, and starting and stopping the motor. All of this can be accomplished by one man in a very short time and with little effort as compared to that required for cleaning the stable by other methods. Several variations of the conveyor-in-the-gutter-type cleaner are as follows:

**Continuous-Chain Type.** The single continuous chain and scraper type is applicable to two gutters when connected at

both ends by cross gutters. The conveyor chain may be brought outside the barn by extending the gutters through the barn wall; thus the manure may be deposited directly into a spreader or into an elevator located below the grade line of the gutter. In one machine, a single continuous conveyor chain is made to travel up and back down the same inclined chute outside the barn, the manure being deposited directly into a spreader located above gutter grade. Thus a separate elevator and power unit are eliminated.

**Reciprocating Type.** In this type a reciprocating rod equipped with hinged scrapers moves the manure along a single extended gutter and deposits the manure into a combination conveyor and elevator which in turn carries it to the spreader. A separate power unit located outside the barn is needed for each gutter. When two or more are installed, each feeds into the horizontal conveyor part of the elevator which is placed outside the barn at right angles to the extended gutters. It is possible to arrange this equipment so that the spreader can be loaded at any corner of a barn in which there are parallel gutters.

**Chain Pull-Out Type.** This type utilizes a double conveyor chain with scrapers placed in the gutter which is extended outside of the barn. The conveyor chain which is pulled out and rolled up on a winding drum outside the stable is designed to deposit the manure in a spreader located above gutter grade. The manure is carried up an inclined chute which is attached to the end of the extended gutter, the winding drum mechanism being located under the chute. One manufacturer provides a single unit which can be shifted from the end of one gutter to that of the next one to be cleaned. Another installation provides separate units for each gutter, the conveyor chain being returned to the gutter by cable and winch.

**Belt Pull-Out Type.** (Fig. 1). Another pull-out type of gutter cleaner employs a rubber conveyor belt in place of the chain and scrapers. The belt is wound up on a drum placed above the spreader at the end of a chute connected to the end of the extended gutter. When the spreader is located above the level of the gutter, the chute is inclined. The belt is returned to the gutter by hand when its length is not more than about 60 feet. A separate unit is required for each gutter.

Even with such a variety of gutter cleaner systems as are available, it is difficult to select one which can be installed

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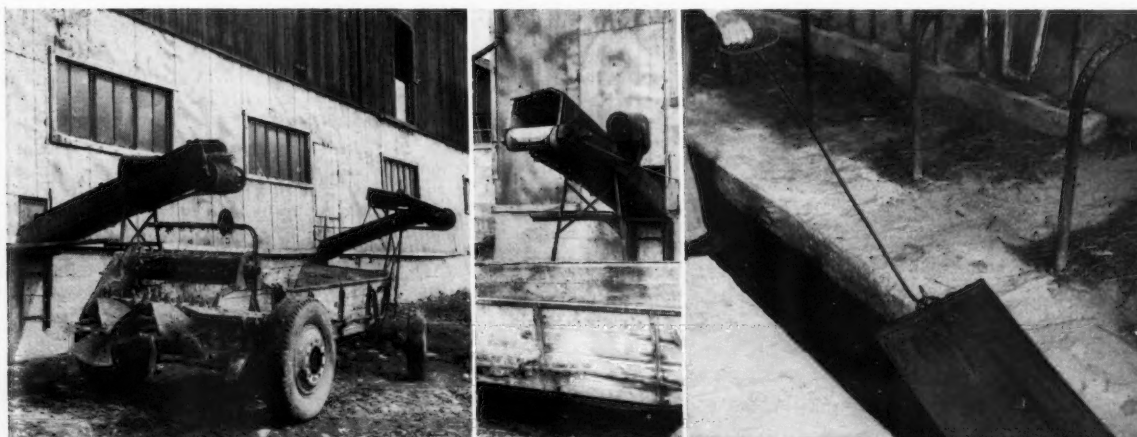


Fig. 1 (Left) Conveyor belt pull-out-type gutter cleaner installed in a Pennsylvania bank barn. The overshoot was enclosed when the dairy stable was remodeled • Fig. 2 (Center) The drum in which the belt is wound when the gutter is cleaned. A clutch controlled from within the barn releases the drum when the belt is returned to the gutter • Fig. 3 (Right) This view illustrates how the belt is returned after the gutter has been cleaned

readily and economically in many barns. The arrangement and construction of the barn, the location of the silo, milkhouse, and other buildings, including the dwelling, and the proximity of roads and drives may affect the choice and installation cost. Remodelling comprises a large part of the cost of many installations. The bank barn, common in the East, with its cross alleys and stone walls usually requires major remodelling to accommodate a gutter cleaner. Such a barn nearly always is on a hillside and frequently the bottoms of the gutters are above the height of the earth on the downhill side of the stable.

Research at the Pennsylvania Station in the development of a rubber belt, pull-out-type gutter cleaner was conducted in an attempt to provide an inexpensive means of mechanically cleaning barns of this type and, at the same time, to develop a method of cleaning resulting in more sanitary and better appearing barns and barn yards.

In the first cleaner which was designed and installed the gutter was extended into a level chute having the same width and depth as the gutter. The chute was made to fold so that the outer 3 ft could be raised to afford additional clearance for the tractor wheel and manure spreader beater. A 14-in, 2-ply rubber conveyor belt was placed in the 16-in gutter, brought over a 4-in roller at the end of the chute, and back under the chute to a 5½-in drum on which it was wound. The drum was driven by a suitable speed reducer and a 1-hp electric motor to give a winding speed of 16 rpm. By means of a double clutch, the same motor and speed-reducing unit was used to return the conveyor belt to the gutter. A wire cable was run from a winding drum to the end of the gutter opposite the chute, through the necessary pulleys, and to the end of the conveyor belt. Thus the conveyor belt could be moved in either direction in the gutter by properly setting the clutch. The total length of the extended gutter and chute was 60 ft.

#### DETERMINING THE TENSILE LOAD ON THE BELT

During the time the first machine was in operation, 11 Guernsey cows were stanchioned along the gutter. The tensile load on the belt was found to vary considerably. This pull on the loaded belt was determined by calculation after measuring the torque applied to the winding drum. By this method the pull needed to start the belt when loaded with 1400 lb of manure was found to be about 800 lb under usual operating conditions. The greatest pull on the belt was found to occur when about one-third of the belt had been pulled out and the manure began to fall from the end of the chute. The maximum pull observed during any test was 1500 lb with a belt load of 1400 lb. Very slight stretching of the belt when it was pulled seemed to be an aid in getting it started. The increases in pull on the belt as it moved in the gutter appeared to be caused by the shifting and consequent packing of the litter against the sides of the gutter and chute. As determined by loading a piece of belt and pulling it in the gutter, the coefficient of friction of the loaded belt in a dry gutter was about 1, and in a wet gutter, about 0.5.

This cleaner was equipped with a calibrated electric motor and several tests were run to determine the power required to drive it. During zero weather, when the speed reducer and motor were cold and the belt load was 1415 lb, the 1-hp motor was overloaded up to 25 per cent. Results of a typical test are shown in Table 1.

TABLE 1. POWER REQUIRED BY CONVEYOR-BELT CLEANER No. 1 WHEN REMOVING 1210 lb OF MANURE FROM A 53-ft GUTTER USING A LEVEL CHUTE. Temperature approximately 40 F

Distance belt traveled, ft	0	10	20	30	40	50	60
Input to motor, w	1000	1060	1100	1100	900	600	500
Motor output, hp	0.82	0.87	0.91	0.91	0.72	0.42	0.30

Much was learned from this installation. It did a very satisfactory job of removing manure from the gutter under both summer and winter conditions. With once-a-day cleaning in winter, as much as 1200 lb of manure accumulated in the gutter. Although the machine demonstrated the possibility of

considerable labor saving in cleaning the barn in which it was installed, this particular design was considered a failure for the following reasons: First, part of the liquid manure followed the belt over the roller, back to the winding drum, and on to the ground. Also, the chute leaked liquid manure at the hinged joint where it folded. It was obvious that the belt should be rolled up over the spreader and that the chute should be made tight to direct all liquid into the spreader. Second, during winter weather the roller tended to freeze fast and accumulate solid material. This together with the tendency of the belt not to run on center over the roller sometimes placed much of the pull on one edge of the belt. Occasionally this was responsible for tearing the belt and part of it had to be replaced at the end of 10 months' use. Third, the belt-return mechanism proved to be a troublemaker. For one reason or another, the operator would upon occasion pull the partially unloaded belt back into the gutter, a practice which caused breakdowns. Redesigning and rebuilding the belt-return mechanism permitted two-way operation without breakage. Although it took less than 2 min to run the contents of the gutter into the spreader and about the same length of time to return the belt to the gutter, this proved too long a period to hold the attention of the operator. After the machine was jammed and broken several times through letting the belt move too far, automatic stop switches were installed. These solved the problem, but the machine had become too expensive and complicated. Therefore, a much simpler machine was designed and installed in another gutter. After observing its operation, the first machine was replaced with a third design. (Fig. 2). At this time the first machine had operated 10 months and the return cable had begun to fray because of corrosion. No effort had been made to lubricate the cable or to protect it from stable fumes and liquid manure.

Experience with the first machine had shown that a belt will carry liquid manure up an incline when ample bedding is used. Since it seems desirable to place the spreader at grade level rather than in a pit which is costly and very difficult to drain and keep clean, the idea of an inclined chute was used in the designs of subsequent machines.

The second and third machines developed were similar and quite satisfactorily met the requirements of the farmer using them. They consisted of an adjustable inclined chute 8 ft long attached to the end of the extended gutter. A 14-in, 2-ply rubber conveyor belt was placed in the chute and gutter with one end attached to a winding drum 7 inches in diameter. This was turned at 12 rpm through a clutch and speed-reducer drive by a 1-hp electric motor. On the barn end of the belt was a large eye. To unwind the belt from the drum and return it to the gutter, the operator first disengaged the clutch and then engaged a large hook in the eye. With this hook he dragged the belt back in place, an operation which required about 20 sec (Fig. 3). For details of this machine, see the plan for a "Dairy Stable Gutter Cleaner" which is available from the Pennsylvania State College, Agricultural Extension Service, State College.

#### EFFECT OF COLD WEATHER ON OPERATION OF MACHINES

No trouble with these machines was encountered which could be attributed to cold weather operation, except when the temperature went below zero. On such occasions it was found necessary to operate the worm-drive speed reducer a minute or so to loosen it before engaging the clutch in order to prevent overloading the motor. The wattage input to the motor was found to remain about the same during the unloading period. As the belt on an installation of this type winds up, its speed increases while actual pull on it decreases; thus power requirement tends to be uniform. The greatest power input to the motor of this gutter cleaner occurred with the fully loaded belt and the chute set at a 24-deg incline just as the manure reached the upper end of the chute. The power input was practically the same as that required by the first machine.

Some difficulty was experienced, particularly when once-a-day cleaning was practiced, with liquid remaining in the gutter when the chute was inclined. It was found necessary to use ample bedding to absorb the liquids in order to remove them satisfactorily. During normal operation the belt lifted 3 or 4

in from the bottom of the chute when the chute was inclined. Because of this and uneven loading, the belt sometimes twisted and unloaded where it started up the chute. The maximum incline for practical operation was determined to be 24 deg and less is considered an improvement. Experiments in holding the belt down at the bottom of the incline indicate that unloading can be eliminated and that liquids can be carried up inclines with much less bedding. To date, however, a satisfactory holddown device has not been developed. Also, it was found desirable during summer operation to clean the top surface of the belt as it is wound up. During the winter when more liquid is present this is not necessary. A scraper has been devised which satisfactorily cleans the belt. It must be released, however, when the belt is pulled back into the gutter.

The belt-type, pull-out gutter cleaner appears extremely simple and easy to operate and to give satisfactory performance in barns which accommodate its installation. The life of the rubber conveyor belt is unknown. The belts observed, with the exception of that part mechanically injured in the first machine, have been in service over two years and they may be good for as many more.

First-hand observations in the field and talks with operators are necessary to determine how new machines actually perform and are accepted. It is difficult to get the facts, however, about gutter cleaners from their users. They are so sold on the need and potential usefulness of their machines that they are inclined to overlook the difficulties experienced. Most users wish to compare the operation of their machines with much disliked hand methods, rather than with the characteristics of other machines. Those who help install and put the machines in operation, farm dealers and rural service men, seem to be less enthusiastic than the users. These men appear to believe that sales talks and advertising claims are too optimistic. Installation of machines in some barns visited required expenditures of time, labor, and money much greater than anticipated.

#### INSTALLATION PLANS AND INSTRUCTIONS OFTEN INADEQUATE

It was learned also from service men that plans and instructions for the installation of cleaners often are inadequate. Available plans were said to lack necessary detail and were engineering drawings rather than pictorial plans which could be read by ordinary rural mechanics. Layout suggestions were said to be lacking. One farmer who installed a cleaner in a barn less than four years old found his silos and milkhouse in the way. He now steps over the gutter cleaner driving mechanism to get into his milkhouse and blames the barn plan which he said should have allowed for the installation of a gutter cleaner.

In visiting farms it was learned that the adjustment of some of the machines as well as their installation was troublesome. This proved costly to both the dealer and the farmer. In spite of such difficulties, the users of these machines were very enthusiastic about them.

Desire for a gutter cleaner seemingly is not always based strictly on dollar values. Saving of time and making a disagreeable job easier and much less objectionable were found to be the chief points of satisfaction expected and derived by users. Such statements as "it keeps the boy at home", and "it makes work more attractive to hired help" are self-explanatory. One farmer stressed in particular the effect of his gutter cleaner upon his health. The machine made it possible for him to haul out the manure each day during winter weather without subjecting himself to the hazard of becoming overheated while forking manure and then taking a cold ride on the tractor. The possibility of substantially increased labor income derived from extra cows cared for in the time saved with the gutter cleaner also was suggested. Another farmer volunteered the opinion that the gutter cleaner was the No. 1 labor saver for the dairy farmer.

Figures recently obtained from two electric power companies in Pennsylvania show that 67 gutter cleaners have been installed in one area covering 40,000 farms and 19 in another area including 15,000 farms. Since dairying is the major farm

enterprise in these areas, it is obvious that gutter cleaners are in their infancy.

Following are the conclusions and recommendations resulting from the study of the conveyor-belt, pull-out-type, gutter cleaner developed at the Pennsylvania Agricultural Experiment Station:

- 1 This device lends itself to installation in many barns, particularly bank-type barns such as are found in Pennsylvania. It is a simple machine which is easy to install, operate and maintain.

- 2 A straight, level gutter which can be extended through the outer wall of the barn is necessary to allow for installation of the cleaner.

- 3 The winding drum must be located over the spreader, and the chute must be tight in order to direct all liquid from the gutter into the spreader.

- 4 Flanges on the winding drum are unnecessary as the belt is guided by the sides of the chute.

- 5 The width of the chute should be the same as the gutter.

- 6 The minimum depth of the chute when straw is used for litter should be 10 in.

- 7 A 7-in winding drum, driven at speeds of 10 to 12 rpm is satisfactory.

- 8 Mounting the winding drum shaft in 2-in hardwood bearings is satisfactory.

- 9 The clutch should be placed to release the winding drum from the final drive so that the drum will turn freely when the belt is being returned.

- 10 Returning the belt to the gutter by hand is a practical method.

- 11 A 14-in belt in a 16-in gutter with normal bedding will do a good job of removing liquids and manure.

- 12 Under some conditions a small amount of liquid will remain in the gutter at the bottom of an inclined chute.

- 13 When sufficient bedding is used to absorb the greater part of the liquid, the manure and liquid are satisfactorily carried up a 24-deg inclined chute.

## Farm Structures—A Forward Look

(Continued from page 568)

building plans. Let us not sell the plan service short. Building plans represent the most effective means at our disposal for influencing farm construction. Bulletins alone are inadequate for the farmer. He must still translate the information in the bulletin into terms of actual building design. We need better plans, plans which incorporate in them the very latest results of our researches. We need a wide selection both as to size and quality of structure. We need more careful delineation, drawings which are adequate but still simple enough that people can understand them readily. We need plans that show structural details as well as arrangement of space. We need a better presentation of these plans so that people can select their needs more effectively. This is a big job.

We need closer cooperation between research and extension men if we are to operate most effectively. The extension men should keep the research men well informed of problems in the field and help them to direct their efforts for the greatest benefit to the farmer. On the other hand, the extension people must be well versed on the latest developments from research. We need closer cooperation not only among the land-grant colleges, but also between the colleges and the manufacturing industry. Successful results can be obtained only when building materials are used in the proper manner. All of us are vitally interested in proper use of building materials.

The agricultural engineer cannot afford to do a mediocre job. There is much ahead of us which will justify the very best efforts that any of us and all of us can give. Housing is a basic necessity. The farmer cannot afford to pay a high price for poor buildings. We need buildings which will help to eliminate drudgery on the farm, raise the living standards, and lower the cost of production, because they serve better and last longer.

# Vermiculite Insulating Concrete in Animal Shelters

By Harvey W. Steiff

MEMBER A.S.A.E.

ONE OF the farmer's oldest problems has been the cold, wet floor in animal shelters. Many farmers have believed that this moisture is due to the capillary action of ground water, and a wide variety of floor constructions have attempted to solve the problem. Some have been improvements over older types, but most have fallen short of their goal.

Our approach has been that cold, wet floors are caused most often, not by capillary action, although this may occasionally be the case, but by temperature differences between the floor and the air inside the building, causing water vapor contained in the air to condense.

The experience of a farmer at Cedar Rapids, Iowa, is a good example. For years this man, who operates more than 20 farms in that area, had been troubled with damp poultry house floors. They were made of ordinary sand concrete, a material with good thermal conductivity. When he built a new poultry house, he was determined to have a floor that would eliminate all possibility of capillary action, which he believed was causing the moisture. He placed a concrete footing 4 ft above the ground. Over this went a reinforced structural concrete floor slab, with a conventional frame house above. The following winter, this new floor was even wetter than the floors in his other buildings. Why? Because the temperature of the air under the floor was colder than the temperature of the ground, thus keeping the temperature on the surface of the floor well below the dew point.

We believe that cold floors result mainly from excessive heat loss to the ground itself, rather than through the foundations. Ground temperatures in many areas are much lower than the air inside an insulated structure, and much lower than the body temperatures of the animals occupying the building. It follows that except in areas of very extreme weather conditions, the ground does not act as a source of heat for the building, but will drain heat from the structure and from the bodies of the animals.

The logical solution of the problem lies in the use of a material that will retard heat loss to the ground and, laterally, through the foundation—a material that is also inexpensive, easily installed, and permanent. Vermiculite insulating concrete is such a material. In the mix recommended for animal shelters, one part portland cement to six parts vermiculite concrete aggregate, it has a K factor of 0.65 Btu, as compared with 12.0 Btu for ordinary sand concrete. It costs little more than ordinary concrete, is installed in much the same manner, and since it is an all-mineral material, it will not rot, disintegrate, or burn.

Seven years ago, the first test floors were installed under our direction in various types of animal shelters on operating farms. We have watched them closely, and have made periodical checks over this entire period. We have found that without exception these floors stay warm and dry in the coldest weather, and are standing up with complete satisfaction. Thousands of such floors have been installed since that time. Vermiculite insulating concrete floors have the ideal qualities of being permanent, sanitary, and fireproof—like sand concrete—and, in addition, furnish the important added values of warmth and dryness.

A number of farmers have inadvertently furnished interesting comparisons of vermiculite insulating concrete and sand-and-gravel concrete in service under identical conditions. Seven years ago, a vermiculite concrete floor slab was placed in a hog house near Lake Park, Iowa. The workmen ran out of vermiculite concrete aggregate with about 10 sq ft of area

to finish, and sand concrete was used instead. This portion of the floor is always cold and damp, while the vermiculite concrete slab is warm and dry regardless of outside temperatures.

Four years ago, a Wisconsin farmer near Thiensville remodeled his dairy barn and placed a vermiculite concrete floor only under the stanchion platforms and center alley. Sand-and-gravel concrete was used for the feeding alleys. Both types of concrete were placed over a gravel fill and a subfloor of clay tile. No matter what the outside temperature, the vermiculite concrete remains dry, while the feeding alleys sweat and become slippery even on damp summer days. The owner was so completely satisfied with vermiculite concrete that he placed it under the floor of his new maternity wing and in a new bull barn.

Another farmer near Humboldt, Iowa, was convinced that the wet floors in his animal shelters were caused by capillary action of ground water. So, when he built a new poultry house, he tried to install a floor that would be impervious. First, he put down a gravel fill. On this he placed a vapor barrier and a 3-in slab of ordinary concrete. This was mopped with 30-gal of asphalt. Next came another concrete slab. Despite these precautions, the floor was just as wet as any he had on his farm. Then he learned about vermiculite insulating concrete, and several weeks later he placed 3 in of vermiculite concrete over the existing floor. During the coldest weather of the past three winters, with temperatures reaching to -20 F and with the same operating conditions as in previous years, this floor has remained dry. The number of bedding changes has been cut in half—a point to be considered with straw selling at \$1 per bale and none too plentiful. His experience led directly to the installation of a number of vermiculite concrete floors around Humboldt.

The thermal capacity of the floor is an important factor in the comfort aspects of an animal shelter. We know that the temperatures of the structural materials will always be lower than the body temperatures of the animals occupying the buildings during winter. When the material in contact with the animal is a good conductor, there will be a greater heat loss from the animal, causing a cold spot that will bring discomfort, possible illness, and lower productivity.

In February, 1947, we arranged for a field trip for members of the Barn Equipment Association, so they could see the performance of vermiculite insulating concrete floors under severe weather conditions. We had hoped for cold weather, and our hopes were answered with a record-breaking blizzard, temperatures of -19 F, and a wind velocity of 70 mph. Despite blocked roads, we were able to visit a number of farms. In every building where vermiculite concrete had been used for floors or wall insulation, we found that building warm and dry. Even more important, the productivity and health of the animals had not been affected by the severe weather. Floors of other materials were either very wet or very frosty, and the productivity of the animals had declined sharply with the onset of cold weather.

Vermiculite insulating concrete is finding many uses on the farm: for masonry wall insulation, both in cavity-type walls and in the cores of blocks, using a 1-to-16 mix; for milk cooling tanks, using a 1-to-3 mix. For roof decks for poultry, hog and milkhouses. For subslabs under radiant-heat floor construction in animal shelters, a trend that should be recognized.

In an experimental project carried on near Minneapolis in co-operation with Northern States Power Company, a milking parlor and adjoining milkhouse were built of vermiculite insulating concrete blocks. The compressive strength of the blocks indicates great possibilities in one-story buildings where light loads are carried by the walls. This masonry milk house has received the highest rating by the Twin City milk inspectors of any in the entire area.

This paper was prepared expressly for AGRICULTURAL ENGINEERING and is based on a talk by the author before the winter meeting of the American Society of Agricultural Engineers at Chicago, December, 1948.

HARVEY W. STEIFF is sales manager, Western Mineral Products Co.

# Some Results of Milking Parlor Research

By J. W. Wilkins

JUNIOR MEMBER A.S.A.E.

**S**TUDIES comparing the loose-housing system for dairy cattle with conventional housing methods have been carried on for the past eight years at the University of Wisconsin-Carnegie-Illinois Steel Corp. cooperative dairy barn research project. As the studies progressed, the loose-housing system was developed and improved. Comparative data illustrated the practicability and possibilities of such a system. Actual farm installations proved that loose housing, properly designed and operated, offered several advantages to the progressive dairyman.

The loose-housing system consists of four basic units: loafing area, feeding area, paved lot, and farm milking plant. Of these four units, the farm milking plant, consisting of a milkhouse and milking parlor, offered many opportunities for improvement. In this unit the farmer does one of the most time-consuming and important single operations on the dairy farm. Technological improvements have been made that cut down labor and increase efficiency at chore time. However, with the exception of the milking machine, little has been done to make the milking operation easier. Present barns leave much to be desired for a fast, efficient milking operation.

The farm milking plant is a new unit not standardized by known precedents nor limited by conventional methods and ideas. The milkhouse has been and is being studied, analyzed and improved, while the milking parlor has received only limited consideration. It is a comparatively new unit embodying two basic types: the floor-level and the elevated (or pit) type parlors. Some studies have been made on floor-level-type parlors; however, the elevated-stall-type parlor offered the opportunity for many improvements in the milking operation that were impossible with any floor-level-type parlor. With this in mind, the milking parlor research project was established in 1947. It is a cooperative project under the Federal Research and Marketing Act.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Rural Electric Division. It is a contribution from the Wisconsin Agricultural Experiment Station as a collaborator under the north central region agricultural experiment station cooperative research project, entitled "Milking Parlor Research."

J. W. WILKINS is research engineer, dairy barn research project, University of Wisconsin, Madison.

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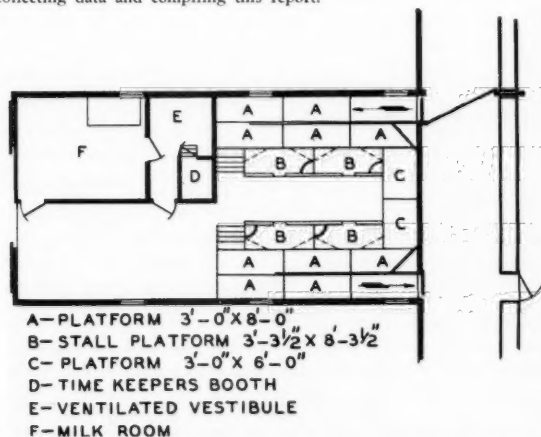


Fig. 1 Floor diagram of milking parlor laboratory with U-type parlor setup

Objectives of the project are:

- 1 To evaluate the possibilities of elevated-stall-type milking parlors
- 2 To compare and evaluate various arrangements of elevated-stall-type milking parlors
- 3 To develop new designs for elevated-stall-type parlors
- 4 To improve existing milking parlor equipment and determine building requirements
- 5 To develop a practical application for milking parlors
- 6 To provide information that will assist in developing milk codes applicable to milking parlors and the loose-housing system. Cooperation has been extended to health authorities on this phase of the project.

Research data on milking parlors were reviewed. However, it was too limited and inconclusive on which to base a research project. Observations were obtained on cooperating farms in Wisconsin and surrounding states. An inspection tour of milking parlors in eight western states was made. Time and travel studies were taken, the operations and operators observed, and sketches made of the layouts. Upon completion of summarizing the data and observations from all sources, one point was clear. A comparison of actual installations would be ineffective because (a) no two were structurally alike, (b) their method of operation was not consistent, and (c) operator effectiveness varied. Actual operating units available for study were insufficient to cancel out these variables. The development of a milking parlor laboratory was considered the best way to achieve the research objectives established.

The laboratory was located in the loafing area of the insulated loose-housing unit at the Wisconsin dairy barn research project. Inside dimensions are 24 x 48 ft. This unit is available during the summer six months. A milkhouse, ventilated vestibule, and timekeepers booth were installed where they would not interfere with the test layouts and still be accessible to all units. The milking parlor equipment consisted of:

- 1 Four steel-framed tables, 30 in high, with wood tops. A milking parlor stall was secured to each.
- 2 A series of steel-framed tables 3 x 8 ft and 4 x 6 ft, all covered with wood, and 30-in high. These formed the walkways and ramps for cows in the parlor.
- 3 Necessary controls, piping, equipment, etc., to facilitate operation.

All the above units are portable and can be moved to form any parlor layout desired (Figs. 1 and 2).

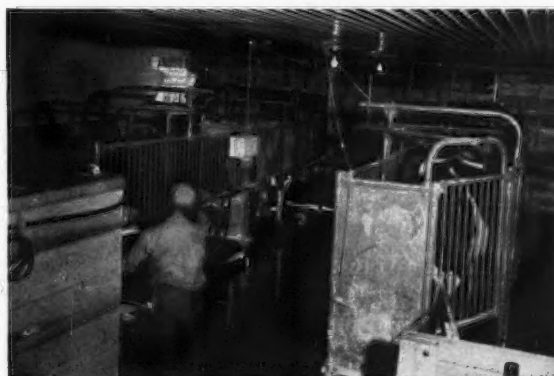


Fig. 2 U-type milking parlor in operation. Three of the four portable stalls are in view. The portable platforms make up the rest of the unit. Note the time-study booth at the left, ropes and pulleys for controlling doors, and easy access to paper towels in dispensers

A U-type parlor was set up in the laboratory. Trial runs were made on a 51-cow herd for six days after they had become used to the parlor. Regular barn help did the milking. Upon completion of this trial run, the data were tabulated and studied. Results were not satisfactory. Variations occurred where operations should be consistent. Several operators had to be used and results were different with each operator. However, the information and data collected did serve as the basis for setting up the present method of checking milking parlors.

To eliminate as many variables as possible, two major changes were made. It was decided the same operator(s) should do all the milking. Sixteen cows were selected from the 51 cows milked in the trial run. These sixteen represented an average, on the basis of time required to milk, of the entire herd. They, or comparable replacements, are to be used for all test work.

The milking operation was established to comply with standard health regulations. Hot water at approximately 120 F piped directly to the stall was used to clean udders after which they were wiped dry with paper towels and foremilked. Machine stripping is practiced and hand stripping eliminated. Machines are rinsed between milking each cow. Where bucket units are used, each bucket of milk is carried to the milkhouse. Cans are placed in the cooler as soon as filled.

The next step was to establish the combinations of operators and milking units to be used in testing each parlor. A bucket unit consisted of one machine head, one blank head, and two buckets. This allowed transfer of the machine from one cow to the other without carrying milk between the change. A releaser unit consisted of a claw assembly connected by rubber hoses to a stainless steel pipe line in which the milk is conveyed to the milkhouse by vacuum. All combinations were based on four-cow parlors, or any grouping within that four-stall parlor that was practical without requiring any rearrangement of stalls. These combinations did not cover all possibilities but should present enough data so that any desired combination could be evaluated.

Upon completion of establishing combinations of operations to be tried, definitions were made of the various operations in the milking procedure. Operations were broken down, but only to the extent that a clear-cut difference could be seen in transferring from one operation to the other. Different combinations required different breakdowns. Even then the timekeepers often found operators doing two or more jobs simultaneously. Since this is one of the advantages of the milking parlor, it would be unfair to limit the operators' work. Therefore, it was occasionally necessary to list two or three items under one time period, and then divide the time by the number of operations when allotting it on the summary sheet. When an operator was doing one operation, and then did another operation while still working on the first, the second operation did not interfere with the first and therefore was not charged for that time.

**Time and Travel Study Procedure.** Time and travel study procedure was standardized as much as possible for all combinations of operation. Table 1 illustrates a copy of the original time-study sheet used by the timekeeper. The milking stalls are numbered in each parlor. The observer fills out the column on cow number, stall number, time and operation while actually taking the original data. The watch is not stopped throughout the test. Upon completion of the study, the column<sup>2</sup> on total time per operation is computed. The total time column is then totaled and must check with the total lapsed time in the time column. This completes the time study data on the original sheet.

Next the distance traveled is computed. To facilitate this operation, a scale drawing of the parlor under test is made. Positions at which various operations take place are standardized (Fig. 3). The operation and stall number columns are followed through simultaneously, and the distance is computed, using a scale to measure distance traveled. This measured distance is then marked down under the distance column, and the column added. Since the distance traveled in the milkhouse should be the same for all units, when

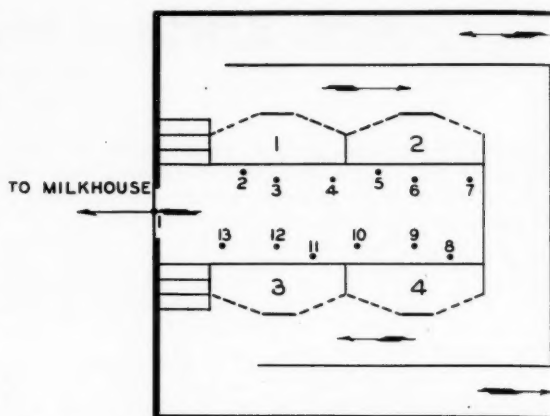


Fig. 3 Points shown on this drawing are standard in relation to each individual stall for all parlors. Point 1 is located at the center of the door to the milkhouse. Points 2, 5, 8 and 11 are located at the cow's udder. Points 3, 6, 9 and 12 are for operating stall gates and door controls. Points 4, 7, 10 and 13 are for feeding grain. Each parlor requires some extra equipment on the floor. This equipment is drawn in and points established to route the operator around the equipment

properly located, distances were figured to the door only. The door was considered located at the point offering the least travel distance for the type parlor under study.

The data were then transferred from the original time-study sheet to summary sheets. The following data are obtained:

1 The figures in the total time column are transferred to the appropriate column in the time-study summary sheet (Table 2). Then each column is added, and a total of all columns made. This total must check with the total lapsed time on the original time study sheets.

2 The time the milking machine is on the cow is computed. (Table 1) This is obtained by subtracting the figure

TABLE 1. TIME STUDY SHEET

University of Wisconsin - Carnegie-Illinois Steel Corp.  
Cooperative Dairy Barn Research Project

Type of parlor . . . U . . . . . Date . . . Aug 7, 1949 (a.m.) . . . . .  
Type of machine . . . bucket . . . . . No. of operators . . . One . . . . .  
No. of machines . . . Two . . . . . Operator . . . J. W. Wilkins . . . . .  
Extra men . . . None . . . . . Observer . . . R. H. Dudgeon . . . . .

Cow No.	Stall No.	Time	Operation	Total Time		Distance	Remarks
				Min.	Sec.		
		0:00					
	1, 2, 3, 4	0:24	Feed	24	33	9"	
	1, 2, 3, 4	1:52	Cows In	28	11	8"	
360	1	1:31	Wash Udder	39	11	8"	
	1	1:51	Machine On	20	5	8"	
59	3	2:29	W. U.	38	13	10"	
	3	3:07	M. On	38	17	0"	
336	2	3:48	W. U.	41	6	2"	
235	4	4:29	W. U.	41	6	0"	
	1	5:22	M. S.	53	6	3"	
	1 - 4	5:58	C. M.	36	8	7"	
	3	6:44	M. S.	46	6	0"	
	3 - 2	7:15	C. M.	31	9	9"	
		7:46	Carry Milk	31	27	6"	
	1 - 3	8:07	C. O. & I.	21	3	2"	
	1 - 3	8:22	Feed	15	29	9"	
327	1	8:47	W. U.	25	12	6"	
	4	8:54	Adj. M.	7	6	3"	
327	1	9:07	W. U.	13	6	3"	
317	3	9:38	W. U.	31	13	10"	
				9	38	234	7"

TABLE 2. TIME STUDY SUMMARY

University of Wisconsin - Carnegie-Illinois Steel Corp.  
Cooperative Dairy Barn Research Project

Date . . . Aug 7, 1949 (S<sub>1</sub>=2) . . . Operator . . . J W Wilkins . . .  
Type of parlor . . . U . . . Timekeeper . . . R H Padojany . . .  
Type operation 1 milking unit . . . Checked by . . . J W Wilkins . . .

	Cows Out	Cows In	Food In Grain	Carry Milk	Wash Udder	Mach. Strip	Change Mach.	Adj. Mach.	Wait	Misc.
10	28	24	31	39	53	30	7	15	70	
02	11	15	22	38	46	38	14			
03	16	18	13	41	30	36	6			
05	05	20	25	41	27	31				
11	11	11	17	25	40	36				
08	08	23	19	13	98	32				
19	20	10	35	31	22	31				
03	05	06	59	38	57	36				
08			13	42	30	27				
				27	26	32				
				34	28	30				
				42	16	32				
				33	16	38				
				37	39	23				
				31	33	29				
				20	20	23				
				28		12				
TOTAL	69	104	127	234	560	581	506	27	15	70

in the time column in front of the "machine-on" (M. On) operation from the figure in the time column before the "machine-strip" (M. S.) column. For example, for cow 360 in stall 1 the machine-on operation was completed in 1 min, 51 sec. The machine-strip operation was completed in 5 min, 22 sec. The actual time the machine was on the cow was 3 min, 31 sec. This procedure was used to find the milking time of each cow for every milking.

3 The time the cow is in the stall. This is determined to compare with actual feed-eating time trials to be run at a separate time. The cow is considered in when the "cows in" (C. I.) operation is completed. She leaves the stall at the start of the "cow-out" (C. O.) operation. Taking cow 360 again, she was in the stall at 52 sec. The last operation before "cow out" was "carry milk" and completed at 7 min, 46 sec. Cow 360 was in stall 1 for 6 min, 54 sec.

4 The order in which cows were milked was determined to see if there was any continuity in milking order from milking to milking. This was found by checking the order in which the machine was placed on each cow.

Upon completion of transferring the above data for each milking, it is compared with other milkings and the averages of each milking totaled. After operation for several days, it was found that two days or four milkings gave sufficient uniformity of figures to compare various methods of milking and types of parlors.

5 Beside the data shown on the summary sheets other relative information is obtained. The individual production of each cow (where possible) and the total herd production record is maintained. The bacteriological aspects of milk produced in milking parlors are under study. Plate counts are taken on individual quarter samples and composite samples of milk taken from the 10-gal cans after milking. Since the cows are the same for all tests, there should not be a noticeable variation in bacteria count between parlors under normal conditions. However, the tests will indicate the quality of milk that can be produced in milking parlors. They will also show the difference, if any, between use of bucket and releaser systems of milking.

6 The most important part of the relative information is

the observation by operators and timekeepers. Ease of operation, fatigue factor, operator vision, equipment, design, convenience, etc., are all noted.

A summary of one method of operation in the U-type parlor is shown in Table 3. Figures are on a cow-per-milking basis. These summaries are then compared with those obtained in other tests on the same parlor. Finally, the summaries will be compared as to results of similar operations of other type parlors.

# RESULTS OF RESEARCH

*Comparative Data.* Basically one of the main objectives of this project is to compare various types of parlors. This phase of the project has been and is in the process of being checked. There are several arrangements or types of parlors yet to be studied. Because of this, it is impossible to present a complete comparative summary at this time.

An indication of the work under way follows. It is a comparison of two types of parlors, the U and tandem, checked under three combinations of operation. However, it does not present the complete comparison of the two types of parlors, as they were both checked under other combinations.

The three combinations shown have several things in common, as to methods used, operator(s) duties, etc. They are:

- 1 All were tested with bucket-type milking units.
- 2 Operator(s) listed did all work, including feeding grain and carrying individual buckets of milk into the milkhouse. Milk from individual cows was not weighed by the operator.
- 3 The distance-traveled figure shown includes only the actual distance traveled in the parlor. The operators did not carry milk into the milkhouse. Since this distance could be standard for all milking parlors with conveniently located milkhouses, it is not included in this comparison.
- 4 All data shown are on an individual cow-per-milking basis and determined by finding the average of the entire herd.

TABLE 3. Summary for Four-Stall, U-Type Parlor Operated by One Man With Two Units

Operation	Average time, sec	Total time, %
Cows out	3.8	2.7
Cows in	8.0	5.7
Feed grain	8.2	5.8
Carry milk	13.6	9.7
Wash udder	36.1	25.7
Machine Strip	34.8	24.8
Change machine	31.9	22.7
Adjust machine	2.0	1.4
Wait	0.2	.1
Miscellaneous	1.9	1.4
Total per cow	140.5	100.0

Cows milked per hour, 25.6

Average machine-on time, 3 min, 39 sec

Average of milk, 16.8 lb

Average distance traveled, 54 ft, 6 in

*Combination 1.* This test was made with one man operating one milking unit in two milking stalls:

	Type of parlor	
	Tandem	U
Man-minutes per cow	3:25.8	3:28
Time machine on cow	2:51	2:52
Cows milked per hour	17.5	17.3
Milk per cow, lb	15.4	17.9
Distance traveled	68 ft 3 in	48 ft 7 in

The difference between the two types of parlors in this test was of little consequence. The level of production was slightly higher in the U-type parlor, and distance traveled was less. Neither of these differences appeared to affect the comparative advantage of the two parlors.

*Combination 2.* This test was made with one man operating two milking units in four milking stalls:

	Type of parlor	
	Tandem	U
Man-minutes per cow	2:39.3	2:20.5
Time machine on cow	4:20	3:39
Cows milked per hour	22.6	25.6
Milk per cow, lb	16.8	17.9
Distance traveled	84 ft 11 in	54 ft 6 in

These figures indicate the U-type parlor was probably more efficient than the tandem unit in all phases tested. Distance traveled was considerably greater in the tandem and this in turn increased the time required to do individual operations where walking was involved.

As the time required to do these operations increased, the operator did not get back to the cow as fast. This resulted in the machine being left on longer.

In comparing combinations 1 and 2, the latter was more efficient in man-minutes per cow required and in total cows milked per hour. However, the machine-on time was considerably greater because the operator did not always get back to the cow in time. Likewise, the addition of a second unit gained only from one-third to one-half in cows milked per hour over the use of one unit. Thus the efficiency per milking unit decreased. The production level was similar in all tests. Distance walked per cow increased in combination 2. The data indicates that the operator did a better job of milking in combination 1. Observation of the two parlors indicated the operators work was easier and accomplished more effectively in combination 1.

**Combination 3.** This test was made with two men operating two milking units in four milking stalls:

	Type of parlor	
	Tandem	U
Man-minutes per cow	3:34.8	3:38.9
Time machine on cow	2:51	2:55
Cows milked per hour	33.5	32.9
Pounds milk per cow	15.4	17.1
Distance traveled	78 ft 1 in	67 ft 8 in

As in combination 1, results of combination 3 showed similarity all the way through. Again distance traveled was greater in the tandem parlor than in the U-type parlor, but this distance did not in this case appear to affect over-all results.

Combination 3 is actually the same as combination 1, except that twice as many operators, milking units and milking stalls were used. In comparing combinations 1 and 3, there was very little difference in man-minutes required per cow and time the machine was on each cow. Cows milked per hour were almost doubled and the level of production was similar. Distance traveled was more in combination 3 than it was in combination 1. Although the operators each worked on two stalls, they would occasionally help one another. This accounts for some of the difference in distance traveled.

Several other combinations, including tests with releaser-type milkers were run on the above parlors. Similar tests will be made on other parlors. There has not been enough data collected as yet to say which parlor is best or if any one parlor will be best. At present, it appears that the comparative efficiency of parlors may differ according to the combination or method of operation. Likewise more data must be collected and compared on the bucket- and releaser-type milking units to determine the comparative advantages and disadvantages of each.

The order the cows entered the parlor was observed. The average difference in the order of milking was 2.25. If each cow required 4 min in the parlor, the average difference in milking time would be 9 min. This is where one milking unit and two stalls were used.

A limited number of tests have been made on the time each cow requires to eat her grain. No attempt was made in these trials to speed up this eating time. It was found that the cows required approximately 1 min per lb of grain consumed plus 1 min. A cow receiving 6 lb of grain took about 7 min to complete the eating operation. The corners in the feedbox slowed down eating, and this phase is under observation at present.

Bacteriological counts have been taken throughout all tests. The average plate count per milliliter was 1900; the highest count recorded was 4200, and the lowest was 200. There has not been enough data collected to date on this phase of the work to say if there will be any difference in the quality of milk produced under various milking conditions.



Fig. 4 (Left) One of the standard feedboxes. The waste of grain is indicated by the amount on the floor. (Right) An experimental feedbox in use at the present time. Sides are higher so the cow will not have as much freedom for the removal of her muzzle from over the box.

Most of the waste was eliminated

The number of manure droppings in the parlor has been observed. An average of about one out of twenty cows will leave droppings when grain is fed in the parlor. This average may vary, depending upon the length of time the cow spends in the parlor. A good deal of the droppings may be eliminated by driving the cows in the holding area just before milking. This exercise cleans the cows out, and if they are not held too long tends to cut down on droppings left in the parlor.

The advantages of elevated milking parlors over milking in conventional stanchion barns are as follows:

- 1 Elimination of stoop and squat involved in milking.
- 2 Operator can milk for a longer period of time with no serious tiring effect due to a reduction in operating fatigue.
- 3 Improved visibility of udder makes it easier to do a thorough job of cleaning, and in less time.
- 4 Improved visibility of the milking machine on the cow makes it easier to determine when attention is required, and facilitates a speedier milking operation.
- 5 Manure, straw and barn odors are eliminated in this small, easily cleaned unit and improved building sanitation is provided.
- 6 Flexibility. A small unit can be used to milk a large herd. The only limit on herd size is the amount of time available for milking.
- 7 Cost. When incorporated in the total cost of a loosehousing system, the milking parlor is still considerably cheaper than the conventional stanchion barn even though it may be of more expensive construction.
- 8 Distance traveled. The cow comes to the operator instead of the operator going to the cow. This cuts down distance traveled and increases operator efficiency.

Following are the disadvantages of elevated milking parlors:

- 1 Animal heat is slow to warm a cold milking parlor, and in cold climates where water is used in the milking parlor auxiliary heat may be desired.
- 2 Observation of the physical condition of the cow is difficult except those conditions pertaining to the udder.
- 3 The settling tank requires frequent checking and periodical cleaning.

**WARNING:** Mastitis and udder troubles can be quickly and easily treated in the milking stalls during milking, providing the necessary materials are at hand. However, elevated milking stalls are not hospital stalls and should not be used as such, if for sanitary reasons alone. For general veterinarian work, a separate area where cows can be confined and tied should be provided.

**Feeding Grain.** One of the most discussed questions about milking parlors is whether or not grain should be fed in the parlor. Both methods have their advantages and disadvantages. Advantages of feeding grain in the parlor are (a) that it

furnishes an incentive for the cow to enter the parlor quickly and of her own accord and (b) that most loose-housing systems do not have individual feeding stalls; the milking parlor provides an efficient place to feed grain on the basis of production, and (c) the centralization of the entire milking operation on a one-man farm tends to increase over-all efficiency.

Disadvantages of feeding in milking parlors are as follows: (a) more stalls are required per milking unit to keep the milking operation going. (b) grain in the parlor causes some dust in the air, and (c) most of the present feedboxes are wasteful. This wasted grain is not only expensive but can also easily clog drains.

At present it appears that the majority of the smaller farms, and especially one-man units, will feed at least part of the grain ration in the parlor. As herd size increases to a larger operation, the trend may be to feeding grain separately. However, units will be in operation where grain feeding is done in the parlor and waste of grain at the feedbox must be eliminated. Work is being done to improve the design of feedboxes (Fig. 4) for milking parlors at present.

**General Design Requirements for Milking Parlors.** The first question in designing a milking parlor is to determine the size of the unit or number of stalls required. Unlike the stanchion barn, the number of stalls is seldom determined by the number of cows. Three factors usually determine parlor size, namely, (a) the number of operators, (b) the number and type (bucket or releaser) of milking units to be used, and (c) whether the feeding of grain is to be done during the milking operation or separately. The first two factors go together. Operators should be warned against trying to use too many units. Though over-all milking time may be decreased slightly, it is not worth while if poor milking habits result. Where no grain is fed, a minimum of one stall per unit is required. However, an extra stall or two may serve to speed up the milking by making it possible to have another cow ready to change the machine to immediately. When grain is fed at a high level of nutrition in the parlor, and fast milking is practiced, two stalls should be available for every milking unit. Where feeding in the milking parlor is light and supplemented by separate feeding of concentrates, good operators may be able to operate two milking units with three stalls quite efficiently.

Occasionally herd size will affect parlor size. Such a case occurs when a known number of operators want to milk a given number of cows within a certain time limit. This time limit also becomes a more important factor in the larger herds. Then the parlor size is developed to handle the herd, providing the cost and time limit are within reason.

When parlor size is determined, the type parlor must next be selected. This should be done on the basis of efficiency of parlor, general adaptability to present building situation and

needs of the operator. Before going any farther, the operator should obtain a copy of the milk regulations and codes in force for his particular market. These codes and regulations should be read carefully and the over-all planning discussed with the local inspector. The use of the tandem and U-type parlors in this report is for reference only and does not constitute a recommendation that they are considered the best parlors.

**Location of Parlor.** Locate this unit on the clean, well-drained side of the barn and lots where good lighting and ventilation can be obtained. It should be serviced by an improved driveway and the yard around the building should be neatly kept.

The parlor should be located conveniently in respect to the milking herd. A holding area adjacent to the parlor for un-milked cows is necessary. This holding area can be the paved, cleaned feeding area in the loose-housing system. It can also be separated from the feeding area, paved, and at least partially covered.

Where there is a natural ground slope it should be used to make up the 30 in difference in elevation between cow and operator if possible. The ideal plan is to have the cows enter and leave at grade level and still permit the operator to walk from milking parlor to milkhouse on the same level. The milkhouse door should be above grade level to make the loading of milk as easy as possible. The milkhouse floor and operators area in the milking parlor should be on the same level. There are three reasons for this: first, the operator can carry milk, equipment, etc., on a level route; second, cows enter the milking parlor satisfactorily on properly constructed ramps, and third, parlors should be, for the most part, designed for general adaptability to any type milking unit or system of milking. General sale value of the unit will be greater, and new tenants or owners will not be limited to definite types of equipment.

**Floors.** They should be smooth concrete or other impervious material, slightly roughened with a clean barn broom where the cows must walk. Floors should slope to gutters or drains so they can be washed quickly and easily (Fig. 5). Drains should have large grills and be connected to the settling tank in the ground just outside the building, with a 4-in vitrified sewer tile or cast iron pipe. Gutters should also lead direct to the settling tank or be equipped with floor drains as described above.

Alley widths for cows should not be over 3 ft wide. Smaller breeds may require less. Where cows must make a 180-deg turn in alleys, 4 ft should be left between guardrail and end of building. Where cows must turn 90 deg, long alleys are still 3-ft wide, but short end alleys are approximately 3½ ft. The elevation difference between operator and cow is 30 in. Installations with less stall elevation have been made, but

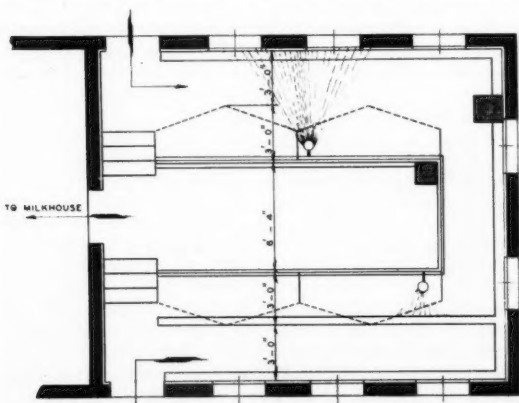


Fig. 5 Floor plan of U-type parlor showing drainage. On the top a single gutter is used, while on the bottom two were installed. Note how much more area must be covered and water used to clean up the same amount of droppings where only one gutter was used

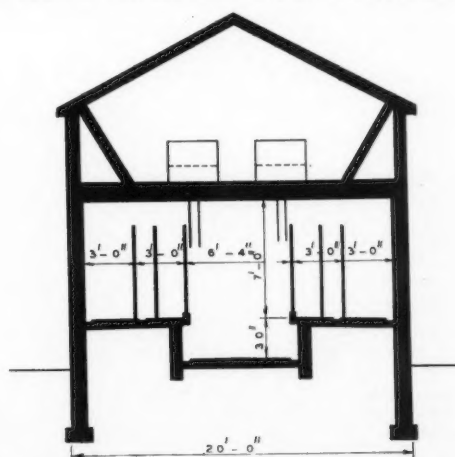


Fig. 6 Standard cross section of U-type parlor showing basic dimensions. The use of overhead storage of grain is optional

the operator had to bend over in an uncomfortable position to work. A curb 4 or 5-in wide is formed on the operator side of the milking stall. Curb height varies from 2 to 4 in. A slot the width of a conventional bucket milking unit should be left in the curb at the middle of the stall so the milking machine can be slid under the stall rail and cow. The sidewall of the operator's pit should have a 6-in overhang around the top to allow room for the operator's toes and to provide a place for water pipes. The operator's floor width should be a minimum of 5 ft where stalls are located on one side only, and a minimum of 6 ft where stalls are located on both sides of the operator. Narrower widths have proven satisfactory where no equipment was placed on the floor. However, where considerable equipment is used, wider widths may be advantageous (Fig. 6).

**Walls and Ceilings.** Walls can be of wood, tile, metal or concrete. Some health codes require concrete 30 in above the inside floor level. Ceiling height should be 9½ ft above the operator's floor level. The ceiling can be of cement asbestos board, portland cement plaster on metal lath, or other impermeable material if smooth. Ceiling insulation is desirable in all climates. Sidewall insulation is desirable in colder climates.

#### THE INTERIOR FINISH OF WALLS AND CEILINGS

The interior finish of walls and ceilings must be smooth, of natural light color or painted a light color, easily cleaned and water resistant. A light-colored or white ceramic facing tile set against the wall makes an ideal wall surface to clean and to reflect light. At present, ceramic tile is not priced out of line with other materials since it requires no painting and makes cleaning faster and easier.

**Lighting.** Effective window area of at least 1 sq ft per 10 sq ft of floor area will be satisfactory, if the windows are well distributed and not obstructed. When using glass block, provide 1 sq ft of window area to each 7 sq ft of floor area. Good lighting by artificial means is an important feature and will be greatly improved by light, clean walls and ceilings. The necessary power outlets in the wiring system for vacuum pump, milk cooler, etc., must be included.

**Ventilation.** Ventilation by screened, insulated outtake flues is suggested, one for each room with 1 sq in of cross section area for each square foot of floor area. Suitable cupolas should be used on the roof. Windows that are full opening are recommended in both milking parlor and milkhouse. Fan ventilation is essential for summer use where glass block are used for all or part of the windows.

**Heat.** While heat is most desirable in the milkhouse during the winter, it is possible to get along without heat in the milking parlor. Animal heat, though slow, will heat the parlor. Water pipes in the parlor can be drained. Ground limestone can be used on the floor. However, some operators may want heat in the parlor. For small units, automotive-type heaters operated from oil-burning hot water heaters have proven satisfactory.

**Water.** Although water in the milking parlor is not always necessary, it is highly desirable. Where bucket-type milking units are used, water can be eliminated from the parlor, but when releaser-type milking units are used, hot water at 185 F, or steam is required for cleaning purposes. In both cases, hot and cold water can be used to an advantage in the milking parlor. The hot water is available for washing udders direct and use in wash cloth and machine rinsing pails. The cold water is used in rinsing milking machines, equipment, and cleaning in the milking parlor. Water under good pressure provides the easiest method of cleaning and keeping the parlor sanitary at all times.

**Vestibule.** Some health authorities require a ventilated vestibule between the milking parlor and milkhouse. This regulation, in the majority of cases, was set up for the stanchion barn-milkhouse combination where the vestibule is a must. The milking parlor-milkhouse combination is an entirely different situation. However, before going ahead with a unit, the inspector should be consulted on the need, or requirement, for a vestibule. Otherwise plan the original layout so a vestibule can be added at any time.

Planning, materials and arrangements of both the milking parlor and milkhouse should be given careful study from the sanitary angle. Convenient arrangement and placement of equipment for thorough cleaning throughout will save time and help meet strict sanitary requirements.

**Operator Problems and Their Significance.** The first problem facing the operator is training cows to come into the parlor. For a day or two some cows will be reluctant to enter the parlor. Normally, after one or two weeks training, they will enter of their own accord without being driven. It is a good policy to have two or three extra men around the first few milkings. Care should be taken in training cows to enter the parlor, so they will not form unpleasant associations with the parlor or milking.

The operator must get used to proper use of controls. Most operators are used to hurrying with their feet rather than with their arms and head. In a milking parlor, a large per cent of the work is done with simple controls. Efficient use of these controls is one of the main prerequisites for a smooth operation.

**Additional Research Needs.** There are several problems that still require more study. The present study of comparative efficiency and adaptability of various milking parlor arrangements must be completed. The possibility of new and better designs is a constant challenge. There is much room for improvement of equipment, and at present special emphasis is being placed on developing a feedbox that permits faster eating and elimination of waste. Results and observations on bucket and releaser-type units are being checked closely to see where each fits in the over-all milking parlor set-up. As the work on the project progresses, new problems and ideas are turning up. It is intended that each of these be given full attention until solved or developed.

#### SUMMARY

**Significance.** In a day when technological improvements are being made in every field of agriculture, the milking parlor serves as part of the contribution to better milking conditions. It is a small, practical, efficient unit. Labor is concentrated. The cow comes to the machine instead of the man taking the machine to the cow. Advantages in ease and speed of milking are obtained that would otherwise be impossible. Good milking procedure can be carried out with full vision of all operations. The milking capacity of an operator can be increased in so far as fatigue is concerned.

**Adaptability.** The milking parlor can be used with either stanchion barns or loose housing. However, predominate use will occur with the loose-housing system. Since the milking parlor is small, the cost per cow is comparatively low. New loose-housing layouts are lower in cost than stanchion barns. However, for every unit constructed, there are several that are remodeled. In most cases, buildings that are unsatisfactory for stanchion barns, though structurally sound, can be turned into loafing and feeding areas at a low cost. A farm milking plant can be normally constructed for less than the cost of remodeling into a stanchion barn. The result is an efficient milking unit that can be easily cleaned and operated, and with a high standard of sanitation.

**Acceptance.** With building costs what they are today, it is not surprising that a large number of farmers are converting to milking parlors. While the farmer with a good set of buildings cannot afford to make changes, there are many who must make improvements to get on premium milk markets. Therefore, as farms require new buildings or remodeling, many are accepting the loose-housing system with elevated milking parlors.

We have discussed the farmers who are in need of building repairs. We cannot overlook the farmer whose present buildings are satisfactory. They are looking ahead to the time when they can, or must, make changes. If the correspondence received, the plan aid given, and the visitors touring the dairy barn and milking parlor research projects are any indication, the loose-housing system and milking parlor are receiving a fair share of consideration. People from Wisconsin, every state in the United States, and many from foreign countries are included in this group.

(Continued on page 580)

# Fire Safety Aspects of Crop Drying Equipment

By L. G. Keeney

ASSOCIATE A.S.A.E.

UNTIL a few years ago it was common practice to leave corn standing in the field until late fall, when the moisture content was sufficiently low to permit safe storage. Field curing was adequate in most years, although picking continued throughout the early part of the winter. Most farmers avoided storage of early picked corn in large quantities, with the result that there was rarely any serious spoilage problem.

The mechanical corn picker and the advantage of early marketing caused many farmers to seek short cuts in the drying process. Mechanical pickers work more efficiently in the early part of the husking season than later, and improved yields require handling increasingly larger quantities of corn. Early picking also avoids the handicap of winter weather.

The process with which this paper is chiefly concerned involves circulation of air which has been heated by artificial means. Evaporation of moisture is accelerated by the addition of heat, and the rate of evaporation is proportional to the amount of heat applied. Artificial heat complicates the drying process by increasing the cost of equipment, the cost of operation, and the danger from fire.

The purpose of this paper is to review some practical considerations of fire loss control, to set forth limitations of artificial drying, and to suggest a few minimum requirements for drying equipment.

**Fundamental Problems in Loss Control.** Grain producers, equipment manufacturers, educational agencies, and insurance companies are among those interested in crop drying processes. It is obviously difficult to reconcile all views of the problems involved. The farmer is interested in safe and economical equipment which will enable him to market farm products under favorable conditions. The manufacturer faces the problem of providing drying equipment which may be sold on a competitive basis. He is not unaware of safety, but he naturally practices economy whenever possible. He is at a disadvantage, in manufacturing crop drying equipment, because standards of design and construction have been indefinite. Agricultural agencies whose interest is the advancement of farming techniques must face the tedious process of research and experimentation. Their endeavors must include all practical and theoretical considerations which the problem involves. In the case of crop processing, the insurance company is expected to become responsible for the mistakes of everyone else. This latter statement is not one of complaint but of simple fact.

The superstition that fire is unconquerable has been dispelled by those who have taken a practical approach to its control. Studies in the Middle West over many years have established that most farm fires result from construction deficiencies or from other conditions which are well within the control of the property owner. For example, fires resulting from defective chimneys have been virtually eliminated by a well-coordinated inspection program conducted over a period of years. Farm fire losses in one state have been slashed by more than 50 per cent as a result of efforts directed at a few simple and easily controlled causes.

The time for applying some practical standards to grain drying is long past due. Most portable driers are still inadequate and unsafe, even after several years of experimentation. From the standpoint of an insurance underwriter, the question is not *if* a fire will occur, but *when*. An insurance company may meet the burden of higher losses by the simple expedient of a rate increase. But this result helps no one since every

fire is an economic loss to the community and to the nation. High insurance rates usually produce the notion on the part of the property owner that he has a hazardous situation and that he is therefore beyond help. Instead of rate increases, most farm fire insurance companies have taken the attitude that it is better to devote time and energy to the control of losses. Grain producers, however, should realize the limitations which are contained in all fire policies. The fire form used in nearly all states contains the following provision: "Unless otherwise provided in writing, added hereto, this company shall not be liable for loss occurring while the hazard is increased by any means within the control or knowledge of the insured . . . . . Many policies contain an additional limitation which refers specifically to crop processing, as follows: "Artificial heat shall not be used for drying or processing hay, grain, or farm products, except by special permit endorsed on this policy."

You will now appreciate the problem of the insurance company when a loss from drying equipment occurs. If the policy holder has not requested a permit, he is presumed to have violated his policy provisions. If he has requested permission to use a drier, the company must determine if the drier meets reasonable safety requirements. About two years ago, the National Fire Protection Association created a technical committee on dehydrators and driers, after which Underwriter's Laboratories attempted to establish standard tests for drying equipment. The NFPA committee and the National Association of Mutual Insurance Companies are attempting to establish reasonable safety requirements, and they must lean heavily upon agricultural engineers for help. It is hoped that tentative standards may be completed in time for formal approval by the annual meeting of NFPA in May, 1950.

**Limitations of Artificial Drying Equipment.** The element of safety has been largely ignored in the production of drying units which may be sold at a low price on a volume basis. Releases by some manufacturers have led unsuspecting farmers to believe that grain may be dried in large quantities at little expense, and with little or no danger. It is natural for a prospective purchaser to take the manufacturer's claim at face value.

There is little basis upon which a farmer may determine his equipment needs. A typical field report describes a drier with air output of less than 5,000 cfm installed on a crib 10 ft wide, 12 ft high and 80 ft long. The crib was filled with corn of high moisture content and no provision had been made for circulation of air. The drier was simply attached to one end of the crib on the theory that the air would pass through 80 ft of corn and thus perform a miracle of moisture reduction. Drier installations which are not based on sound engineering practice may result in overheating part of the corn and saturating other sections of the crib to the point that spoilage is inevitable. Many farmers are now completely prejudiced against artificial drying equipment because of unfavorable experience on their farms or those of their neighbors.

**Minimum Requirements for Drying Equipment.** Grain-drying installations require the knowledge and skill of a heating engineer the same as any other heating operation. Design of a duct system, calculation of static pressure against which the blower must work, determination of the output of the burner and the blower, and ascertainment of the power and fuel requirements are a few of the factors which must be taken into account to achieve a safe and efficient drying operation. Satisfactory installations cannot be expected on a mail-order basis or through dealers whose principal business is selling lumber or stock feed.

Manufacturers have a responsibility to provide drying equipment with such protective devices as are necessary for safe operation. Installations should be made according to the same standards that are taken for granted in heating systems for residences or other purposes. Those manufacturers who

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have developed equipment which is safe by all reasonable standards should be complimented. They should not be made to suffer the consequences of the short cuts taken by manufacturers of cheap units.

High combustibility of farm products and buildings in which drying equipment is used calls for strict adherence to safety standards. There is no room for makeshift equipment, with low cost as the only consideration, unless we are to become resigned to unnecessary loss of grain, cribs, and adjacent farm buildings. The hybrid seed corn industry has been able to reduce fire loss in drying operations by recognizing the hazards which exist, and by outlawing those hazards through the use of well-designed equipment. The following appear to include most of the important considerations of fire safety:

**Heating Units.** The capacity of the burner should be sufficient to meet the required heat load without having to resort to excessive drying temperatures. An important safety rule is to use only heating units in which the source of heat may be controlled positively by automatic means. Coal stokers, oil burners, and gas heaters fall in this classification but all manually fired units are ruled out. Oil burners which are most commonly used for grain drying should be of the atomizing type. Gravity-flow burners are not safe because they are difficult to ignite and because the oil flow cannot be controlled effectively. Oil burners should have constant spark ignition and should be equipped with controls to open the electrical circuit in case of ignition failure or lack of fuel.

There has been some question about routing the products of combustion through the warm air ducts and into the grain. Some heat loss is avoided by this method but at the expense of safety. In addition to the problem of screening, there is the ever-present hazard of fire flashing throughout the crib if combustion is incomplete. A safe compromise is a heat exchanger which transfers heat from the stack to the drying duct, while permitting smoke and soot particles to escape. Still safer is a permanent installation consisting of an automatic blower and heating unit attached to a standard chimney. Regardless of the type of heating unit used, the air inlets to the burner should be screened to prevent husks and other inflammables from being drawn into the air stream. The usual safety precautions as to fuel supply, fire extinguishers, etc., should be taken.

**Power.** The blower should be electrically operated and should be connected to the same circuit as the burner. Thus, the entire system stops in the event of power failure or other interruption. Electrical operation of controls and equipment is a must. Tractors or gasoline engines are hazardous as a source of power because it is difficult to control them when overheating occurs.

**Automatic Controls.** Automatic controls necessary to safe and efficient operation consist of (1) a limit switch which will stop the source of heat immediately if the temperature within the drier exceeds a safe limit (this control should stop the burner but should permit continued operation of the blower or fan), (2) an electrical control to stop the flow of fuel in case of ignition failure, and (3) a switch which will keep the blower in operation when the temperature in the burner exceeds a minimum setting.

**Temperature.** Hybrid seed corn processors are forced to limit drying temperatures to 110 F because a higher temperature destroys germination. As germination is not a consideration with grain for feeding purposes, there has been a tendency to increase drying temperatures to the point that safe operation is questionable. Some manufacturers recommend operation at 200 F in order to shorten the drying period and to compensate for lack of capacity. It seems that 135 F is an acceptable limit when drying corn for feeding purposes.

**Recommended Installations.** There are two general types of installations which may be relied upon for safe and efficient grain drying. The first is a permanent drying unit installed in a building designed for grain processing. The electrically operated heating unit is attached to a permanent chimney and is equipped with all of the automatic controls which are necessary for safe and efficient operation. The drying bin or bins are designed to permit free circulation of heated air so that

uniform drying is possible. The bin capacities are such that grain may be dried within a few days without resorting to excessive temperatures.

The second classification consists of portable driers. Such units should be entirely automatic in operation to avoid the necessity of constant attendance. The blower motor should be attached to the unit, and all electrical thermostats and controls should be installed at the factory. The high-temperature side of the limit switch should have a maximum setting within safe limits. The power requirements and the capacity of the unit should be designated on the name plate.

Portable driers should be used with single-batch bins, preferably portable, well-separated from buildings used for permanent storage. Such equipment will permit safe operation and will accommodate only the amount of grain which the drier will process efficiently.

#### CONCLUSION

The necessity of occasional use of artificial heat for crop drying must be recognized. Farmers, agricultural agencies, and equipment manufacturers will probably move toward one of two courses of action. The first is to permit use of inadequate, unsafe and poorly-installed drying equipment on the fatalistic premise that fires are inevitable. This course prejudices insurance companies, with the result that excessive rates and other penalties are imposed on the property owner. It fails utterly to solve the problem of preventing economic waste. The second course is for all agencies to work together toward improvement of drying techniques not requiring artificial heat, while establishing high standards for manufacture, installation, and operation of drying equipment. Farmers will either depend upon natural drying processes, or they will demand quality driers, once the limitations and dangers of inadequate equipment are made clear.

### Milking Parlor Research

(Continued from page 578)

The general acceptance, the value of the improvement to the farm business, and the degree of success attained by milking parlors are dependent upon four main factors, as follows:

- 1 The acceptance of the loose-housing system, since the two are directly related.
- 2 Definite standards for the production of milk under the loose-housing system of management being universally established. Some regulatory bodies have already provided regulations for their markets, while others are studying the requirements.
- 3 Proper planning for efficient, practical use. This includes designing the loose-housing system so full benefits of mechanization can be attained.
- 4 Capable operators. Operators making the change to the loose-housing system must be good managers. They must also have the ability to work effectively with and to adapt themselves to a new system.

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# Measurement of Soil Moisture by the Electrical Resistance Method

By G. J. Bouyoucos and G. A. Crabb, Jr.

MEMBER A.S.A.E.

THERE has always been a great need throughout the field of agriculture for definite information as to the amount of soil moisture present in the profile. This need is particularly felt in many phases of agricultural engineering, especially those relating to research, hydrology, irrigation, drainage, and other divisions where the question of soil moisture is of importance. Careful study of the subject will show that, of the many methods of measuring soil moisture, most will fit the following classification<sup>27\*</sup>:

- 1 Methods based upon gravimetric determination
  - (a) Determination of the amount of moisture actually present in soil samples
  - (b) Determination of the amount of moisture in porous media in moisture equilibrium with the soil<sup>14, 30, 23, 42</sup>
- 2 A method dependent upon the resistance of the soil to penetration<sup>1</sup>
- 3 Methods which depend upon the measurement of the equilibrium tension of the water in a porous pot in contact with the soil<sup>14, 35, 36, 40, 46, 52</sup>
- 4 Methods based upon the thermal properties of soil or porous media in moisture equilibrium with the soil<sup>25, 49, 50</sup>
- 5 Methods which depend upon the electrical properties of soil or porous media in moisture equilibrium with the soil<sup>2, 7, 9, 11, 16, 19, 32, 55, 3, 4, 15, 18</sup>

A most comprehensive study and comparison of the relative merits of these different methods of soil moisture determination was made over a period of two years at Salinas, Calif.<sup>27</sup> This study directly compared the conventional method of drying soil samples in an oven with the gravimetric sorption block of Davis and Slater, the thermal unit of Shaw and Babber, and the tensiometer method of Richards, with the electrical resistance method<sup>7</sup>. Data were obtained from the same locations by these several methods using 13 sorption blocks, 150 thermal units, 300 tensiometers, and 900 Bouyoucos blocks. In presenting the comparative results of this study the investigators stated that the electrical resistance method of determining soil moisture "is the most practical instrument available at the present time for measuring moisture changes at tensions above one atmosphere in soils not containing large amounts of salts." In view of the fact that increased use of this method indicates that such feeling is becoming widespread, and because of improvements in the blocks themselves, as well as the instrument for measuring block resistance, the opportunity is welcomed to review this method of moisture determination before such a prospectively interested technical group.

Fundamentally this method of measurement consists of the determination of variations in the electrical resistance of one or more porous, or absorbent, elements buried at strategic spots in the soil profile. To accomplish this end, two devices are necessary—a suitable resistance element and a resistance bridge especially adapted for the purpose. This paper will discuss the plaster of paris and nylon resistance elements<sup>7, 5</sup>, and the modification of the Wheatstone bridge, known as the

Bouyoucos Model C resistance bridge, in detail. Certain other types of resistance elements will be discussed most briefly.

The principles employed in this method are relatively simple. The instruments of application, as finally developed, are also simple. Essentially, the method consists of placing a porous element within the soil profile. Such an element, carefully selected, tends to establish relatively rapid moisture equilibrium with the soil. Its moisture content then varies directly with the moisture content of the soil. If this element is composed of a substance which, when dry, is a fairly good electrical insulator, the electrical resistance of the element will vary directly with the moisture content of the element (and the soil) because of the conductive powers of water. This variation in resistance provides an accurate measure of the moisture content of the soil. It is a relatively simple matter to prepare a curve showing the resistance-moisture relationship. Thus, in conjunction with a suitable resistance-measuring instrument, determination of the moisture content of the soil can be easily made.

In developing resistance units to measure variations of soil moisture, it was found necessary to control the area immediately adjacent to the electrodes. This was necessitated by the errors introduced by variations in soil compaction, texture, and salt concentration accompanying the use of bare electrodes. Exhaustive tests indicated that bare electrodes were totally unsuitable for use in such an element. Accordingly wide search was made for a suitable "control" material which would have the necessary qualities of absorption, stability, inertness, and economy. In this search a great many materials were tested. Among them were fire-processed clays, cement and concrete mixtures, dental casting compounds, various gypsum materials, rubber, resins, plastics, glass, asbestos, fiberglass, cellulose sponge, etc. Of the large number of variable insulators tested, first plaster of paris and later nylon elements were found to be the most satisfactory for general use. All other materials tested have been found to have major faults of one kind or another, the most general being that though highly sensitive to moisture, and durable, most substances seem to suffer sufficient structural change in a wetting-drying cycle to prohibit the establishment of suitable moisture-resistance relations upon duplication. This inability to duplicate readings is almost non-existent with both the nylon and plaster of paris elements.

The unit first developed for this purpose was a plaster of paris block. Inside this block were two electrodes connected to wire leads. This block, being highly porous, will—when buried in the soil—absorb moisture from the soil and give it up very readily, so that its moisture content is in constant moisture equilibrium with the soil. The electrical resistance of the block varies with its moisture content, and that with the moisture of the soil. Thus, by measuring the electrical resistance of the block, the soil moisture may be determined.

As now manufactured, these blocks have an average life-expectancy of approximately five years under moderately dry conditions, and one year under semisaturation. Instances of longer life are at hand, but they are the exception rather than the rule.

The blocks have been so standardized that for most practical purposes they need not be individually calibrated. However, for extreme accuracy under unusual soil and moisture conditions, it is recommended that each unit be individually calibrated in the soil in which it is to be installed. This calibration is not a difficult process and has been fully described elsewhere.<sup>7</sup>

The plaster of paris block accurately measures soil moisture percentages from field capacity to the wilting point. This

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\* Superscript numbers refer to appended bibliography.

is a limited range, but roughly the range of available water in the soil, so this unit is of particularly advantageous use to the agronomist and plant physiologist. However, this unit does not possess a wide range of sensitivity, nor does it have a suitably long life expectancy under conditions of saturation. For these reasons, it is not a wholly adequate tool for the engineer and hydrologist, who are primarily interested in a unit which will give accurate measurements over a range from saturation to air-dryness, nor is the plaster of paris block suitable for use under conditions of high concentrations of salts. However, in the moderately humid zones, in combination with the special bridge developed for the purpose, it is the most practical soil moisture determining instrument yet devised for those particularly interested in its ranges of adaptation.

Because of the disadvantages to be found in the plaster of paris block, an intense program of research has been continued in an effort to develop an element capable of replacing it. Failing in that, it was hoped to develop a unit which would supplement the block under conditions adverse to its use. This has been developed in the nylon unit.

This nylon unit is made on the same principle and acts on the same principle as the plaster of paris block. Essentially it is made of two perforated extremely thin nickel plates, or two pieces of fine monel screen acting as electrodes to which are attached wire leads. These electrodes are separated by wrappings of nylon. The whole assemblage is contained in a perforated metal case which has been pressed under high pressure and the edges of the metal mechanically united to permanently enclose the whole. The case has 2/10-in square holes, 1/4-in center straight, and is 64 per cent open. The holes cover the entire surface of the case, thus affording a large amount of soil exposure to the absorbent. Units so constructed quickly achieve and maintain moisture equilibrium with the soil and provide a highly sensitive and accurate measure of the moisture therein. They are, in fact, even quicker at reaching equilibrium than the plaster of paris blocks, more highly sensitive to moisture changes, and largely lacking in the "lag" that has been noted in the use of these latter. The nylon units are markedly durable under field conditions and give almost identical readings upon repetition of moisture conditions. Fig. 1 and 2 show the type moisture-resistance curve produced by the plaster of paris and the nylon units. These figures clearly demonstrate the difference in sensitivity, particularly under extreme moisture conditions.

When used under research conditions, it is advisable to calibrate the nylon units in the soil in which they are to be buried. Ample instructions for this calibration are available.<sup>7, 5</sup> When the unit is used as an "indicator," it is satisfactory to use precalibrated curves.<sup>5</sup> These precalibrated curves are the result of exhaustive laboratory tests of the characteristics of moisture-resistance curves for a wide range of soil and types. The tests in question definitely established four major patterns of curve resulting from readings made with the nylon unit. These patterns are exemplified by the results found with Miami silt loam subsoil, Clinton silt loam, Imperial clay, and Plainfield sand.<sup>5</sup>

Because of the interest shown by some authorities in a fiber-glass unit,<sup>12</sup> careful laboratory tests were made of this material as a moisture indicator. Units composed of this material were found to be definitely inferior in sensitivity in comparison with the nylon type. In addition, the nylon unit

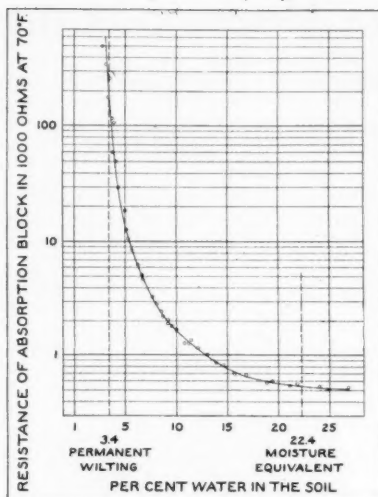
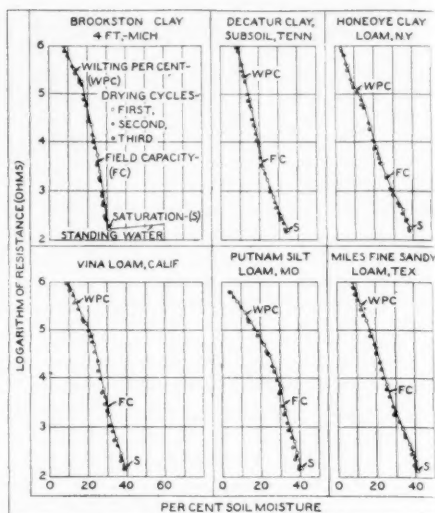


Fig. 1 (Left) Plaster of paris block calibration curve • Fig. 2 (Right) Typical calibration for nylon blocks in different soils



gave a much more smooth and regular pattern than fiber glass on single and multiple wet-dry cycles. In fact, plotted resistance-moisture relationships for three drying cycles with the fiberglass unit gave three distinct curves, whereas the nylon unit duplicated itself. It was found that fiber glass has a tendency to react chemically with some soils, and to absorb appreciable amounts of soil salts, with consequent modification of unit calibration.

Because of its inertness, the nylon unit has almost no buffering action. However, under individual calibration this seems to be of little significance. Its stability and uniformity of result definitely indicate this point. The inert characteristics of nylon is of great importance in high salt-content soils. Of course, high concentrations of salt have a tendency to decrease the sensitivity of the unit, but this is in a large measure compensated for by the relatively large amount of exposure of the units absorbent to the soil. Temperature effect on the resistance of the nylon, though apparent, is of negligible importance. The sensitivity of the unit at high moisture levels is in striking contrast to all other units examined and is one of its most outstanding characteristics. The unit is especially recommended for the use of engineers and hydrologists and is an ideal supplement to the plaster of paris block in the hands of the agronomist and plant physiologist. It is possible that, following wider trial of the nylon unit, it may very well replace the plaster of paris block. However, it must be repeated that—within their limitations—these two blocks are the most satisfactory devices yet developed for determination of soil moisture variations in the field.

In the development of these two resistance elements, it was early determined that a suitable resistance-measuring instrument was not available. Commercial instruments on the market at that time had insufficient range, were entirely too delicate and bulky for field use, and were found to be much too expensive for general use. Accordingly, a special instrument was devised and released for commercial manufacture.<sup>7</sup> This instrument was later refined and modified to meet the standards developed by further research and suggestions from users in the field. As now manufactured, the device is a compact and self-contained unit, ruggedly built to provide a high degree of sensitivity and extremely wide range. It has been so designed as to provide accurate readings on nylon and plaster of paris blocks located up to 200 ft distant.<sup>8</sup>

Essentially this instrument consists of a modification of the Wheatstone bridge, using a high-frequency electronic oscillator. Headphones are used for determining the "null" or focus points inasmuch as they have proved more satisfactory for field use than "electric-eye" indicators, galvanometers, etc. The

circuit is a relatively simple one, resulting in extreme simplicity in the operation of the bridge, durability, and accuracy.

In any discussion of the construction of the bridge, it might be well to start by noting that the instrument is housed in a wooden case. Such a case aids materially in shielding the instrument from ground currents, which invariably cause difficulties in satisfactory operation of a metal-cased bridge. A large condenser has been incorporated in the circuit to counteract the capacitance found in field circuits. These two factors, ground currents and capacitance, cause serious derangement of results unless compensated or eliminated.

The bridge is powered by self-contained dry batteries which activate a 2,000-cycle oscillator. To obtain a very wide range of sensitivity, two series of standardized resistances are inserted in opposite arms of the bridge. Through the use of multiplier switches, the resistances are properly combined, and a final balance is obtained through adjustment of a logarithmic potentiometric rheostat. Thus the bridge is balanced by manipulation of five dials only. This requires but a few seconds in the hands of an experienced observer, and results in very precise balancing of the instrument.

This highly refined, special-purpose bridge has many advantages over both the general-purpose bridges usually found in laboratories, and the earlier models from which it was developed. Specifically, the Model C bridge is lighter and more portable than any comparative bridge, it is self-contained and extremely rugged in construction, and has a sharp null point and an extremely wide range (5,000,000 ohms). Its extremely high frequency oscillator produces a loud, sharp signal that is in great contrast to the almost total silence of the null point. In combination with either the plaster of paris or nylon blocks it makes an ideal instrument for field determination of soil moisture under varied conditions.

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(Continued on page 585)

# A Modified Venturi Section for Measuring Irrigation Water in Open Channels

By J. E. Ferguson and J. E. Garton

JUNIOR MEMBER A.S.A.E. JUNIOR MEMBER A.S.A.E.

THE measurement of water is a difficult problem in many areas where irrigation is practiced. One of the major difficulties encountered is the lack of sufficient elevation head, due to low canal gradients, to allow the use of such common water-measuring devices as the weir or Parshall measuring flume. On many canals where the slope does not exceed 2 or 3 ft per mile, introduction of such devices would decrease the canal velocities below the minimum required.

*Characteristics of a Desirable Irrigation Water-Measuring Device.* The characteristics which a suitable measuring device must have under these conditions are (1) a low resistance to flow, (2) easily measurable head or differential head, (3) small effect from silt or debris depositions created by the device, (4) freedom from clogging by debris, and (5) simple construction and low cost.

Although the venturi tube seems to fit most of these requirements, the conventional type of tube has three serious limitations as an irrigation water-measuring device. First, the throat area is fixed; consequently, a venturi tube may not have sufficient range of capacity to measure with reasonable accuracy the wide range of flows frequently encountered in irrigation canals. Second, the difficulty of constructing converging and diverging conical sections from concrete make them expensive and impractical in many instances. Third, the entrance and exit losses of the pipe section in which the venturi tube is installed may create excessive over-all losses.

Weirs of various types conform to two of the criteria, as stated above, for a good measuring device. However, they do not have a low resistance to flow, as indicated by the loss of

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J. E. FERGUSON and J. E. GARTON were graduate students in agricultural engineering, Utah State Agricultural College, Logan.

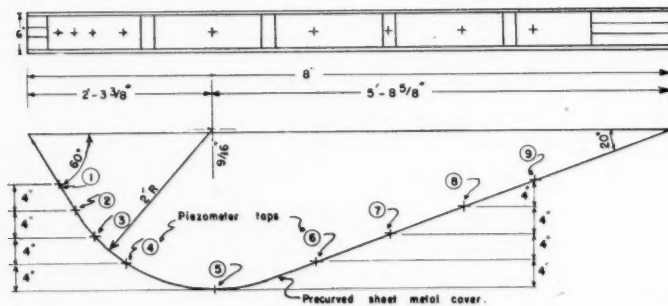


Fig. 1 Test model of a modified venturi section for measuring irrigation water in open channels

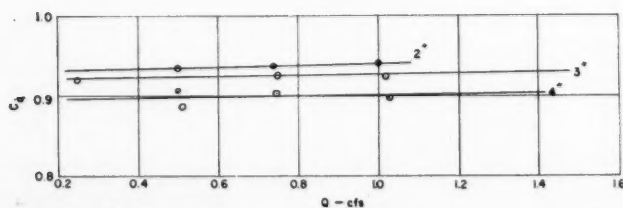


Fig. 2 Coefficient of discharge versus rate of flow, of various throat depths

hydraulic head required for an aerated nappe. The Parshall measuring flume, although now probably the best device for use in canals with low gradients, violates to a certain extent the criterion of simplicity, and to a lesser extent the criterion of low resistance to flow, inasmuch as the required head loss is a function of the total head measurement, which depends upon the size of structure and flow.

*Brief History.* The type of device described herein is believed to have first been suggested by I. H. Teilman, chief engineer of the Consolidated Irrigation District in California, who devised a modified venturi section and applied it to measurement of flow in a rectangular concrete flume. Later, W. P. Yallalee, a student at the University of California, conducted a laboratory study, at the suggestion of J. E. Christiansen, then assistant irrigation engineer at the University of California, to determine the most efficient shape for a modified venturi section which could be formed by introducing a curved cover section into a rectangular flume.

The present investigation, under the direction of J. E. Christiansen (dean of engineering USAC), was directed toward the determination of the characteristics of a device which has a shape somewhat similar to that proposed by Yallalee, but one which could be constructed more easily. The shape of the cover section is shown in Fig. 1. The characteristics determined were the coefficient of discharge,  $C_d$ ; the hydraulic head loss,  $H_L$ , caused by the device in per cent of the differential pressure head created, and the best locations for piezometer taps for measuring the differential head on the device. The tests were conducted in the hydraulic laboratory at Utah State Agricultural College.

*Modified Venturi Section and Flume.* The modified venturi section is formed by introducing a curved cover section (Fig. 1) into a rectangular flume. The closed section thus formed becomes a modified venturi tube with a rectangular throat section. Such a device may be constructed with either a fixed or adjustable throat area.

The experimental flume, in which the tests were conducted, is 48 ft in length. It was built from exterior plywood contributed for these tests by the Douglas Fir Plywood Association. The cover section was built from a strip of galvanized corrugated sheet metal contributed by the Hardesty Division of Armco Drainage and Metal Products, Inc. The corrugations, parallel to the direction of flow, furnish the stiffness necessary for this type of construction.

*Test Procedure.* The procedure used in testing the device was to vary the depth of water upstream and the rate of flow over wide ranges while holding the throat depth constant. For each of four upstream depths and six throat areas, five rates of flow were used.

Pressure heads were measured upstream and downstream from the device, and at nine points along the center line of the cover section by means of piezometer taps connected to a bank of manometer tubes. The actual flow was measured by means of a plate orifice in the supply line leading to the experimental flume.

The coefficient of discharge of the test section was calculated from the equation

$$C_d = \frac{Q \sqrt{1 - (A_5/A_n)^2}}{A_5 \sqrt{2gH}}$$

which is derived from the equation of continuity and the Bernoulli theorem.

In the equation,  $C_d$ , is the coefficient of discharge, an abstract number.  $Q$  is the rate of flow in cubic feet per second.  $A_0$  is the area, in square feet, of a vertical plane passing through the piezometer tap at the throat and limited in extent by the boundaries of the flume and the cover section.  $A_n$  represents the area on the vertical plane passing through the piezometer tap under consideration, that is, tap 1, 2, 3, or 4.  $H$  is the differential head, or difference, in feet, between the levels of water standing in the pair of manometer tubes under consideration.

For a given throat area, this equation reduces to  $Q = K\sqrt{H}$  where  $K$  is a constant.

By measuring the differential pressure head in this manner, the device becomes independent of any upstream or downstream depths as variables in the calculation of flow. The head losses between the upstream and downstream piezometer connections, attributable to the model, were determined by subtracting the normal flume losses (obtained by calibration) from the losses observed with the model in operation.

**Discharge Coefficient.** When the coefficient of discharge  $C_d$  is plotted against the flow  $Q$  (Fig. 2),  $C_d$  is found to vary about 5 per cent with throat depths of 2 to 4 in. However, for a given throat depth the device will measure water with an error of not more than 2 per cent. When the hydraulic head loss is not a critical factor, a wide range of flow may be measured with a given throat depth.

**Head Loss.** When the hydraulic head losses caused by the device are plotted against the differential pressure head (Fig. 3), the upper envelope curve has the equation  $H_L = 0.45 H^{0.88}$ . For a differential head of 10 in, for example, the head loss was less than 3.4 in, or 34 per cent of the differential head. An approximate relationship is  $H_L = 0.3H$ , or a head loss of approximately 30 per cent of the differential head. Since the cover section can be easily moved up or down to adjust the throat, the differential pressure head created can be limited to any amount desired. This is especially important where allowable head loss is critical. The device measures accurately with a differential pressure head as low as 2 in, which would involve a head loss of less than one inch.

When installed in an ordinary irrigation canal, there will be additional head losses at the entrance and exit of the rectangular flume. There has been no opportunity in the laboratory to study these losses. In lined canals it would be possible to construct a cover section to fit the slope of the banks and eliminate the need of a rectangular flume, although such a structure would have a fixed throat area.

Piezometer taps 4 and 5 were found to be a satisfactory combination for measuring the differential pressure head. Taps 1 to 3, inclusive, were not submerged for all conditions of the tests, and there was a relatively small pressure drop between taps 1 and 4.

While we believe that the device is entirely practical, we also believe that further research concerning the problem is essential. Typical problems and questions for further study are: (1) What would be the relative differences in characteristics of a device whose cover section is trapezoidal? (2) Would the losses be of such larger magnitude as to make such a shape impractical? (3) What would be the effect of pivoting the device about the downstream end to facilitate the changes in throat depth? (4) What would be the relative magnitude of the additional head losses at the entrance and exit of the rectangular flume section when installed in an open ditch?

A field test at the outdoor Cooperative Irrigation Research River Laboratory (SCS and USAC) near Logan is planned. The authors will heartily welcome any suggestions or criticisms of this progress report concerning a modified venturi section.

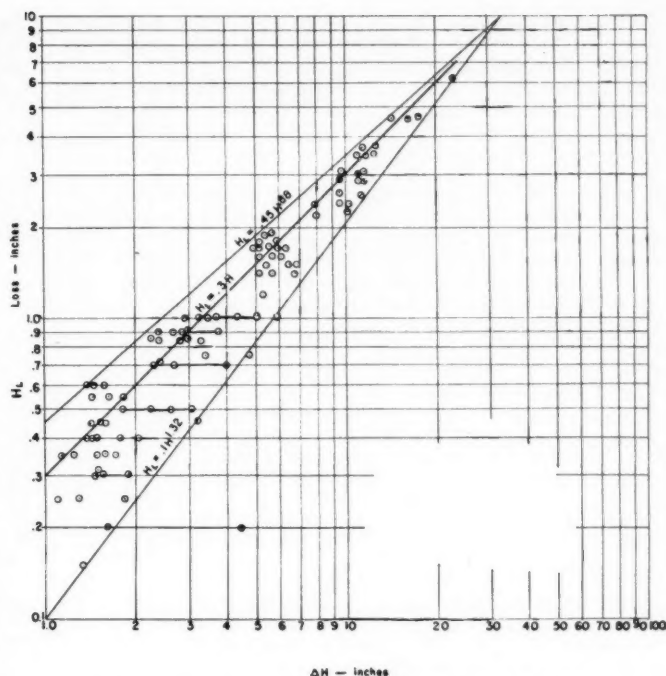


Fig. 3 Head loss in inches versus differential head in inches

## Measurement of Soil Moisture

(Continued from page 583)

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## A CORRECTION

THE following corrections in the paper, entitled "A Continuous Spray-Type Seed Treater", by R. A. Kepner and L. D. Leach, in AGRICULTURAL ENGINEERING for November, 1949, should be made in Table 1 on page 521: The nozzle rating number for run number 8 should read "80015," and the nozzle rating number for run number 9 should read "80002."

## Training Specialists in Conservation

THE first student to complete the soil and water option in agricultural engineering at Oregon State College graduated this past summer. The revised curriculum leads to the degree of bachelor of science in agricultural engineering, granted by the school of engineering. Included in the agricultural engineering course work are classes in the basic sciences of engineering and in addition such advanced civil engineering courses as structural analysis, reinforced concrete, hydraulics, and hydraulic machinery. In addition to these pertinent engineering courses, the student receives special instruction in soils, soil conservation engineering, irrigation engineering, etc. The agricultural engineering department believes this combination of courses qualifies the agricultural engineering graduate to better fill positions in conservation engineering work, including farm irrigation and drainage, than does the curriculum in any other branch of engineering.

# Grain Values to be Safeguarded During Conditioning and Storage

By K. S. Quisenberry

**C**ONDITIONING and storage are very important steps in grain production and marketing. It has been estimated by the Food and Agriculture Organization that the present world losses of grain in storage amount to about 26 million metric tons, roughly equivalent to 950 million bushels of wheat, per year or about 6.6 per cent of the total cereal production of 48 of its member countries<sup>10\*</sup>. In the United States the losses have been estimated at 10 to 15 per cent, although no exact figures are available. The losses vary for years, crops, and areas.

*Causes of Losses.* Losses are listed by Oxley<sup>10</sup> as due to insects, rodents, fungi, and other microorganisms and living processes in the grain itself. All except those due to rodents are greatly dependent on moisture content of the grain and the temperature conditions which prevail. In the United States, for example, losses on a percentage basis are most serious in the warm South and the humid eastern states and least in the drier, cooler western states.

All storage losses are theoretically preventable; that is, they can be greatly reduced or eliminated entirely if owners and handlers are sufficiently concerned. One reason for them is that they are usually insidious, the damage being done before the owner is aware of danger. It would seem therefore that a first step in preventing losses in conditioning and storage is to acquire an understanding of how, why, and under what circumstances they are likely to occur.

*Insects and Rodents.* Losses from insects and rodents are not difficult to understand. A first consideration in preventing such losses is suitable storage structures that are rodentproof and susceptible to fumigation. For me to attempt to tell agricultural engineers how to build such structures would be comparable to carrying coals to Newcastle or worse. In recent years much progress has been made in developing better insecticides and methods of application for the control of insects, but this problem also is one for entomologists and engineers rather than for agronomists. My remarks will be confined to those problems that more properly come within the field of the agronomist with perhaps some diversion into the overlapping field of the cereal chemist.

*Harvesting the Crop.* Many problems will be avoided if grain goes into storage in a dry and sound condition. We may well, therefore, first give our attention to some of the harvesting problems and situations that lead to damp or moist grain.

Harvesting small grains is a rush job. There is always the danger of hail or windstorms that may destroy the crop, and consequently the primary concern of the farmer may well be to get the crop out of the field as promptly as possible. He may realize the danger of damp or moist grain, but if the U. S. Weather Bureau is predicting storms, he may be pardoned if he decides to cross none of the storage bridges until he gets to them. The combine has greatly speeded up the harvesting operation, but it has also introduced new problems especially related to storage. Special problems arise in those areas where much of the harvesting is done by custom operators. The operators are anxious to work fast and move on to the next job. There is often a tendency to cut too early because of fear that machines for harvesting will not be avail-

able at a later date. Delayed harvest risks additional exposure to rain with consequent bleaching and the lowering of test weight. Green weeds tall enough to be cut by the combine are often a serious hazard as they make for difficult operation and moist trash in the grain. The longer harvest is delayed, the more serious this problem will become. The use of 2,4-D in recent years has greatly reduced this hazard but has not entirely eliminated it. The mechanical corn picker has also accentuated the storage problem with corn because the picker works better in grain that is not too dry, and there is also a tendency to pick early in some sections to get the crop off the land in time to seed wheat. Due to a shortage of machines it is often necessary to keep going, although conditions are not the most favorable for harvest. As will be discussed in more detail, recent advances in artificially drying both corn and small grains should help materially in those areas where these crops are harvested with combines or mechanical pickers.

*Storage of Dry Sound Grain.* Dry sound grain can be stored safely for many years if placed in bins or cribs that keep it dry and free of insects and rodents.

Fifield and Robertson<sup>3</sup>, for example, have reported milling and baking tests of Marquis and Kanred wheat stored for 14 to 22 years in dry, unheated rooms at Ft. Collins, Colo. The grain was in good condition when it went into storage. They found no consistent effect on the protein content of the grain. The ash content of the flour increased with storage, possibly due to brittleness of the bran coat causing it to pulverize and be carried into the flour during milling. There was an increase in fat acidity with values indicating deterioration, but it was possible to make satisfactory bread from the wheat. Thiamin content did not change materially. The Marquis wheat germinated 91.5 per cent after 11 years and 22 per cent after 22 years storage, while Kanred wheat germinated 90 per cent after 9 years, but only 4 per cent after 21 years.

The milling and baking results for a sample of Turkey winter wheat representing 800 bu harvested in 1927 and stored in a farm bin in Norton County, Kansas, for 11 years were reported by A. F. Swanson<sup>13</sup>. During this period the wheat had never been turned, ventilated, or moved in any manner and had never been fumigated. When removed from the bin in 1938, it showed no evidence of damage from insects or other causes and contained 11 per cent moisture. Seed planted in soil in the greenhouse germinated 53 per cent. The wheat milled satisfactorily and produced a good loaf of bread. The quality compared favorably with that of other wheat grown in the same region in 1938.

C. O. Swanson<sup>14</sup> has reported on a small lot of Turkey wheat free from weevil that had been kept in a covered tin pail in a granary loft for 25 years. The grain appeared to be plump, hard, and in first-class condition but "failed to show life in a single kernel" when subjected to a germination test. It behaved almost normally in milling but produced a very poor loaf of bread as compared with the current crop.

It would seem from these somewhat fragmentary data that wheat can be safely stored for several years without serious or even noticeable deterioration in milling and baking quality provided it is kept dry and free from insects. Probably other grains also can be similarly kept for considerable periods of time without marked deterioration in quality.

*Storage of Damp Grain.* The most serious and difficult problems in preventing storage losses are related to high-moisture grain. It is now generally agreed that microorganisms which are always present on grain in large numbers are the primary cause of deterioration in storage. Biological or chemical activity of the grain itself is probably a factor but is generally regarded as of secondary importance. Milner and his associates<sup>8</sup> have been able, by the use of especially devised

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\* Superscript numbers refer to the appended bibliography.

techniques, to quantitatively separate the respiration due to molds or fungi on the grain and that due to the grain itself. It was found as expected that as the moisture content of the grain is increased the respiration of both increased. But the respiration due to the fungi increased many times faster than that of the grain. At 16 per cent moisture, for example, respiration due to molds was about 30 times as great as that due to the grain itself, though the respiration of the two were about equal at lower moisture levels.

Recently Carter and Young<sup>2</sup> have shown that heat damage in storage can be entirely accounted for by the energy released in the respiration of the fungi on and in the kernels.

These and other investigations pointing to similar conclusions naturally raise the question of whether damage might not be prevented by treating grain with fungicides. Milner<sup>7</sup> has indicated some possibilities in this direction, but at this time the practical application might be questioned because all that could be expected would be a slowing up of the rate of deterioration, not prevention.

Carter and Young<sup>1</sup> showed experimentally that the condition known as "sick" wheat can be produced artificially by storing sound wheat in airtight containers at suitable temperatures for sufficient lengths of time and without any visible evidence of fungus growth. Fat acidity and the percentage of "sick" kernels increased, and the germination of the grain decreased, with moisture content of the grain and with temperature. The possibility of incipient growth of fungi being a factor was not certainly excluded, but it seems more reasonable to attribute deterioration to other causes.

**Moisture Limits for Safe Storage.** An important requirement in the storage of any grain is rather precise knowledge of the safe moisture limits. The maximum limit for safe storage may be quite different for different areas, and for short-time storage, usually during winter months, as compared with long-time storage which may include the hottest seasons of the year. The safe limit for hard red spring wheat, for example, is often regarded as around 14.0 or 14.5 per cent. Actually such wheat can be stored with a reasonable degree of safety only during the cooler portion of the year. Normally the heat of summer is past and cooler weather is on its way when spring wheat is placed in storage. If marketed and milled before spring, losses seldom occur. Hard winter wheat under the same conditions would keep as well but in the principal winter wheat-growing areas harvesting is earlier and damage is more likely to occur because of the higher temperatures likely to prevail during the earlier storage period. "Sick" wheat, for example, has been reported in hard winter wheat with moisture content no higher than 12 per cent and Carter and Young produced "sick" wheat artificially in soft winter wheat with a moisture content of 12.2 per cent in 279 days at a temperature of 104 F, but not at a lower temperature. Some increases in fat acidity and loss in germination were observed in less time and at lower temperatures. These observations suggest the generalization that, when grain is to be stored for more than a few months or in areas and situations where it is likely to be subjected to high temperatures, the safe moisture limit is considerably less than where the opposite conditions prevail.

The safe moisture limits for other grains have been even less accurately determined than for wheat. Milner<sup>6</sup> indicates that the critical moisture level for the growth of fungi on wheat is about 14.5 per cent, for corn 14.0 per cent, and for flaxseed 10.5 per cent. This is for sound grain. Immature, frosted, shrivelled, or otherwise damaged grain may support mold growth at a lower moisture content. Also respiration of the grain itself or possibly chemical changes in the grain embryo proceed at lower moisture levels so that these limits may be too high for long-time storage in areas of high temperature. The possibility of damage in stored wheat with a moisture content around 12 per cent was mentioned before. Hukill<sup>4</sup> suggests that ear corn with a moisture content of 20 to 21 per cent may be expected to stay in good condition and dry down to 13 to 15 per cent moisture by early summer if placed in an ordinary bin with no hindrance to ventilation. For shelled corn to be left for a year or more the moisture

content should be brought below 13 to 13.5 per cent, and even less if stored in warm climates.

Storage of threshed grain sorghums presents an especially difficult problem because the crop is grown in relatively warm climates and the grain is easily cracked or injured in threshing which promotes the growth of molds. Shedd and Walkden<sup>12</sup> indicated that the maximum moisture content of grain sorghum for safe year-round storage in a tight bin is about 13 per cent under Kansas conditions. Grain with 15 per cent moisture binned in the late fall showed no visible damage until a period ranging from April to June. The loss of germination and the increase in the fat acidity were greater than in the grain with less than 13 per cent moisture.

The storage of barley for malting presents a slightly different problem since the viability must be maintained. Fortunately most malting barley is grown in relatively cool climates and most of it reaches terminal markets where it can be watched by experienced grain handlers, and properly cared for if the need develops.

**Artificial Drying.** Recent progress in drying grain, both by forced ventilation of unheated air and by the use of heated air, offers many possibilities for improving the condition of grain storage. Since this is largely an engineering problem, I shall confine my remarks to a few of the requirements which merit consideration from the viewpoint of the ultimate consumer. Obviously the drying, as for example by heated air, must be done in such a manner as not to materially injure the quality of the grain for whatever use it may be put. Precautions seem to be especially necessary in drying barley intended for malting or any grain to be used for seed. The drying temperature also seems to be very critical for rice. Much of the rice is now harvested by combines and artificially dried. Maximum yields and quality are secured if harvested when the grain contains from 20 to 25 per cent or even 28 per cent moisture—altogether too high for storage. If allowed to stand in the field until the moisture content is below 20 per cent, or if dried too rapidly after harvest, the kernels may be checked or cracked resulting in a low yield of head rice. Since the safe moisture limits are about the same as for wheat (around 14 per cent for rough rice to be milled rather quickly and 12 or 13 per cent for longer storage) considerable drying is necessary<sup>8</sup>.

There is much yet to be learned about the temperature and rate of drying necessary for insuring good quality of all grains. For rice, a moderate temperature of 100 to 110 F seems desirable for the best quality. Higher temperatures increase the capacity of the driers but probably at the expense of milling quality. In some cases drying has been done at 130 F without serious sacrifice of quality. For rice with 20 per cent or more of moisture, it is recommended that the grain be put through the drier at least four times with 12-hr intervals between runs rather than to do the drying in one operation.

The effect of heat on the milling and baking quality of wheat is not entirely understood. Oxley<sup>11</sup> reports that 150 F is the limit for safe drying, while Mounfield<sup>9</sup> suggests 160 to 200 F, with 180 F the safe limit. Apparently these temperatures do influence milling and baking behavior although the reports are not consistent. In some cases and with some baking methods there was no change; in other cases there was improvement and in still others some injury.

It is generally believed that corn also may be seriously injured by drying too rapidly or at too high temperatures. Yung<sup>16</sup> dried ear corn at 190 to 200 F with no immediate visible damage, but shelling revealed shrivelled, brittle, and discolored germ ends of the kernels. Ear corn was discolored when dried at 300 F. Chemical analysis revealed no significant differences between the artificially and naturally dried corn, and feeding trials with rats gave inconclusive results. Others have indicated that corn should not be subjected to temperatures above 180 to 200 F if feeding value is not to be impaired.

There appears to be a special need for more information regarding the effect of heated air on the quality of corn for

wet and dry milling. Wagner<sup>15</sup> for example, has indicated that temperatures of 180 to 200 F are too high; in fact, he apparently feels that artificial drying is not the answer to the high-moisture problem for wet milling. Grain sorghums also now play an important role in the wet and dry milling industry and here also naturally dried grain is preferred to that artificially dried at high temperatures.

Special precautions are necessary for grain that is intended for seed, including hybrid corn and barley for malting. It is usually recommended that in drying corn a temperature of 100 to 110 F may be used at the start when the moisture content is high, and later when some moisture has been lost a temperature of 120 F is safe. Barley for malting should not be exposed to temperatures above 122 F or germination will be reduced. Rice seems able to stand temperatures as high as 130 to 140 F if the moisture content is not too high. It is generally considered that a temperature above 120 F is dangerous to viability, unless the moisture content is rather low.

From the examples cited, it would seem that additional research designed to determine the effect of temperature and rate of drying on feeding, milling and baking quality, and on viability would be especially useful if not essential in working out sound procedures for artificial drying. It is entirely possible, if not probable, that the temperature and rate of drying for the best quality would be quite different not only for different grains but also for the initial and subsequent stages in the drying process. It is only by having such information that artificial drying can be carried out with a minimum of loss in quality and maximum efficiency.

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## Improved Rolling Coulter Design

By J. W. Martin

MEMBER A.S.A.E.

**A** KEEN insight into the practical problems of farm machinery operation and the ability to solve mechanical problems of design as they develop are two criteria which all young agricultural engineers must possess. It is an appreciated although not an accomplished fact that every piece of equipment that now exists can be improved upon in some way.

One example of what can be done is shown in the effort of a young undergraduate agricultural engineering student at the University of Idaho. During the field testing of rolling coulters for trash-covering ability, a problem was encountered and recognized with respect to the present method of attaching the coulter shank to the bearing casting. In severe plowing conditions the bolt holding the coulter-bearing casting to the

shank would fail in tension. The problem and its solution are presented here.

Fig. 1 shows the present method of attaching the bearing casting to the coulter shank. The uneven support of the lower nut on the casting caused bending and eventually failure in tension of the cap screw. Fig. 2 shows the detail of the hardened steel nut used for gripping the coulter bearing casting.

The solution that was developed by the student working on the problem is shown in Fig. 3. A slightly different type of nut was designed. The new nut was made of mild steel and casehardened to make the jaws hard enough to bite into the casting. The threads were NF instead of NC. The jaws were rounded near the edge so that there would be less concentration of stress at the corners. To minimize the chances of failure of the bolts, hardened steel cap screws of the type used in automotive construction were used in place of the original bolts.

This paper was prepared expressly for AGRICULTURAL ENGINEERING. J. W. MARTIN is head, agricultural engineering department, University of Idaho

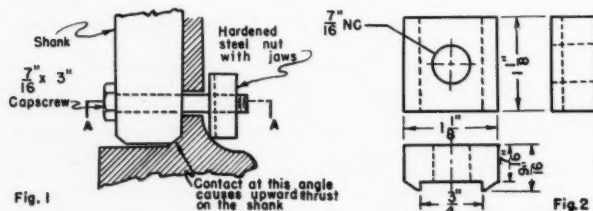


Fig. 1 (Left) This shows the hardened steel nuts, as used on the original equipment, for gripping the coulter-bearing casting. Note how the uneven support of the lower nut on the coulter shank caused bending and eventually failure in the cap screw • Fig. 2 (Right) Detail drawing of the hardened steel nut as originally used

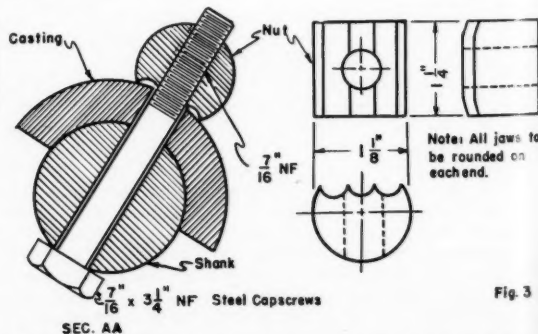
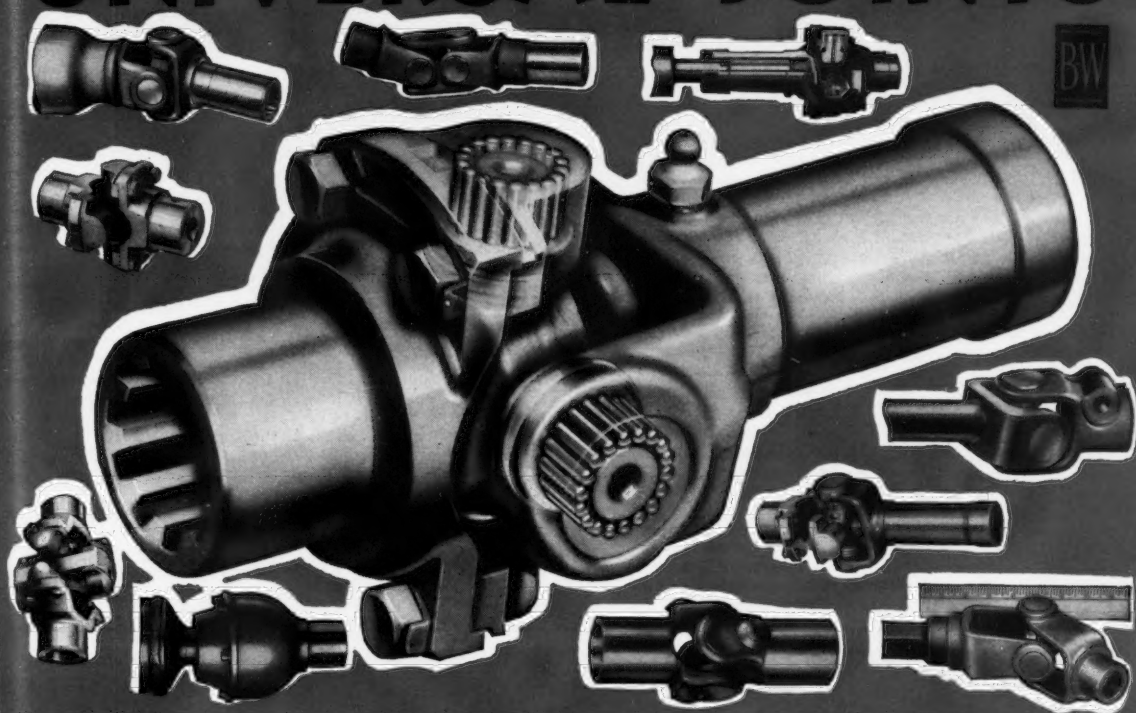


Fig. 3 New type of bolt and clamp nut designed to reduce failures

# MECHANICS

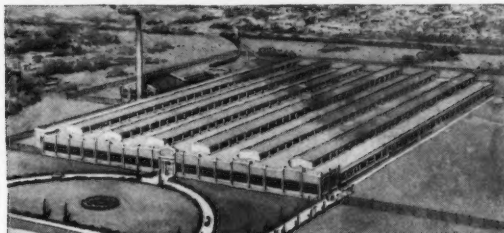
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## RESEARCH NOTES

A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

### USDA NOTES ON BUILDING PLANS, RICE DRYING, AND REFRIGERATION PROJECT

**Farm Building Plans.** The revision of the USDA Northeast Plan Exchange is completed and brown line prints of working drawings for the 103 farm service building plans are now available to state colleges in the northeast region. J. R. Dodge, Division of Farm Buildings and Rural Housing, attended a meeting of the Northeast Plan Exchange Committee held at State College, Pa., September 7 to 9 in conjunction with the North Atlantic Section meeting of the American Society of Agricultural Engineers. The committee made final decisions on the inclusion of drawings in the new catalogue now being prepared for the printer. Only 3 plans will be used as they appeared in the old catalogue issued in 1937 as Miscellaneous Publication 278, Plans of Farm Buildings for Northeastern States. Twenty-eight of the plans have been extensively revised to incorporate modern features; 72 are entirely new.

In addition to the 103 farm service buildings, the Northeast Plan Exchange includes 15 new farmhouse plans developed cooperatively by the state colleges and extension services of the region, the Bureau of Human Nutrition and Home Economics, and the Division of Farm Buildings and Rural Housing. Most of these plans are adapted to either frame or masonry construction by means of alternate detail sheets, and complete alternate working drawings for concrete masonry construction are available for six. The houses are illustrated separately in Miscellaneous Publication 658, Farmhouse Plans for Northeastern States, issued December, 1948.

**Radio-Frequency Rice Drying.** The Farm Electrification Division and the Louisiana Agricultural Experiment Station at Baton Rouge, La., are cooperating under RMA in investigations on the use of radio-frequency dielectric heating for drying and conditioning rice. Finis T. Wratten is the engineer in charge for BPISAE. He was formerly an instructor and graduate student in electrical engineering at Louisiana State.

Most rice is now combined when the kernels are at a moisture content too high for safe storage. The grain is then commonly dried by a warm air draft, but there are limitations to the method. The moisture

content of the rice can be lowered only gradually by means of several excursions through a drying unit. If faster rates of drying are used, surface checking results and in the milling process the grains are shattered.

Radio-frequency dielectric heating differs from other types in that the heat is generated within the material itself, by absorption of energy from an alternating electric field. With most other types of heating the temperature of the inner material can only be raised by thermal conduction from the outside. Another important characteristic of dielectric heating is the evenness and extreme rapidity with which the temperature can be raised. It is possible that rice can be dried by this method economically and without the undesirable effects of surface checking. This could also apply to corn, small grains, and grass seeds.

Plans for the new project include applying radio-frequency power at various frequencies and time intervals to different types and varieties of rice selected at successive stages of harvesting. The treated samples will then be inspected for microscopic surface checking, vitamin content, comparison of taste when cooked, germination, and fatty acid content.

**Refrigeration Project at Three Locations.** In cooperation with the Bureau of Human Nutrition and Home Economics, the Farm Electrification Division is engaged in a three-part study of modern requirements for refrigeration on the farm. Harry L. Garver is the agricultural engineer in charge. In the engineering laboratory at the Research Center, Paul Davis, BPISAE engineer, and Paul James, physicist with BHNHE, have built a farm-type general-purpose walk-in refrigerator with three compartments, one for frozen storage at zero, a chill room or general purpose storeroom at 35 F, and an egg storage compartment. Plans for maintaining the temperature in the egg compartment have not yet been developed nor has the optimum temperature for egg storage been determined. Tests will be run on the refrigerator when loaded with the object of determining the most suitable design factors for farm refrigerators.

At College Station, Tex., P. T. Montfort and J. P. Hollingsworth have built a constant temperature room in the agricultural engineering laboratory of the A. & M. College of Texas. Within it they plan to test a refrigerator built with design features dictated by the results of a survey throughout Texas completed last December. After tests in the constant temperature room the refrigerator will be tested in the field under actual farm use.

At Pullman, Wash., M. C. Ahrens is making a study of existing refrigeration on farms to determine how the equipment is being used. He is interested in working out the correlation between refrigeration facilities on the farm and use of the community locker plant. A buying intention survey for 1949 in the state of Washington indicates that nearly 4,500 people intend to buy farm freezers.



This sacred shrine of all patriotic Americans—Mount Vernon, home of George Washington, and 15 miles from Washington, D. C.—will be visited by many ASAE members during their sojourn at the Nation's capital for the 43rd annual meeting of the American Society of Agricultural Engineers, June 19 to 21, 1950

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than a year  
with no major  
overhauling!**



Mr. D. A. Ross (left), of Ross Farming Company, Edinburg, Texas, and Texaco Man, Roy Greisel, watch as young citrus tree is watered. Cotton is grown on land until trees come into bearing.

Here's a test of petroleum products far tougher than that of most farming operations: 10 trucks running day and night — 24 hours a day in blistering heat, over uneven ground—to water 100,000 young citrus trees on the 2,000-acre farm operated by the Ross Farming Company, Edinburg, Texas.

After more than a year of this operation, truck engines needed no major overhauling—thanks to Havoline, the motor oil that cleans as it lubricates. Havoline stood up to the high temperatures of continuous day and night engine running.

Truck chassis took the hammering of

constant off-the-road operations over uneven ground, but bearings were protected—thanks to Marfak, the lubricant that sticks to the job better and longer. Marfak doesn't melt down and drip out, dry out or cake up; and this operation proved it.

The truck engines had plenty of power in Texaco Fire-Chief gasoline to pull their heavy loads. As Mr. D. A. Ross expressed it, "The terrain is rough, the job is tough; but with Texaco we do right well."

Ask your Texaco Dealer how he can save you money in 1950. You'll find that it pays to farm with Texaco Products.



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Havoline Motor Oil not only cleans as it lubricates, insuring more power; but it also protects against rust when engines are idle. That is why keen ranchers and farmers, like Mr. L. L. Unfred (right), superintendent of Woodland Ranch near Claremont, California, use Havoline in their tractors, cars and trucks. Popular Texaco Man, Bob Baynham, is shown on left.



Friendly service and top quality products are causing more and more farmers to depend on their Texaco Men for their fuels and lubricants. Mr. L. M. Huffman (left), prominent farmer of Alvin, Illinois, gets that kind of service from Texaco Man, E. C. Woodrum.

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## NEWS SECTION

### Committee Recommendations Pay Off

**A** TWO-DAY technical short course on irrigation was held at the University of Tennessee, September 15 and 16, in direct response to a recommendation by a steering committee on supplemental irrigation in the Southeast Section of the American Society of Agricultural Engineers, providing an added example of what can be accomplished by committee work in the sections as well as in the Society as a whole.

The committee was established in May, 1948, as a result of action taken at the preceding yearly meeting of the Section. It was assigned the task of determining the scope of existing irrigation investigations, and recommending means of furthering the orderly development of supplemental irrigation in the Southeast.

Work of the committee soon brought to light a strong feeling among its members that there was a need for an irrigation technical short course, to bring together manufacturers of irrigation equipment, dealers, personnel of public agencies, and others interested in irrigation in the Southeast.

A short course of this nature was recommended to and approved by the Section. Subsequent planning and action by the committee resulted in the course being held at the University of Tennessee.

A total of 83 attended, including 26 representatives of manufacturers and equipment dealers, 7 power company representatives and consulting engineers, one agricultural editor, 13 representatives of the TVA, 11 college instructors, 10 experiment station workers, 8 extension agricultural engineers, and 7 men from the Soil Conservation Service.

The course opened with an address by Dr. J. H. McLeod, dean of agriculture, University of Tennessee, and the following other papers were presented at the first session: "Pointers in Selecting Irrigation Equipment," by J. C. Hundley; "Methods of Distributing Irrigation Water," by H. M. Ellis; "Pumping Equipment and Pumps for Southeastern Irrigation," by R. L. Cook; "Sources of Power for Irrigation," by A. L. Kennedy; "Sprinkler Spacing for Uniform Distribution," by Ed Holland, and "Application of the Giant Irrigation Sprinkler to Southern Crops," by H. L. Wood.

A field demonstration and display of equipment occupied the afternoon of the first day.

The second forenoon program included the following numbers, "Soil Characteristics as They Affect Irrigation Practices," by E. A. Schlaudt; "Application of Fertilizers in Irrigation Water," by John R. Carreker and W. B. Land; "Value of Certain Agricultural Practices on Irrigated Crops," by L. M. Ware; "Rooting Habits of Southern Field Crops," by L. J. Strickland; and a summary of research results by states, with Jack Conniff, J. M. Johnson, John R. Carreker, W. B. Land, J. L. McKittrick, F. E. Edwards, H. M. Ellis, W. P. Low, T. W. Edminster, J. B. Ewing, and A. B. Strand presenting available information from nine southeastern states.

The course ended with an afternoon session on problems in irrigation design, with discussion, questions, and answers from the floor.

Members who have served on the committee include James Turnbull, H. M. Ellis, R. L. Cook, A. T. Hendrix, F. A. Kummer, W. J. Liddell, and T. W. Edminster.

### Alabama Section Meets

**T**HE Alabama Section of the American Society of Agricultural Engineers held its fall meeting at Auburn, Ala., November 4. Fifty agricultural engineers were present for the meeting, which was also attended by twenty-three members of the Alabama Student Branch of ASAE.

The one-day program began with a tour of the new annex to the agricultural engineering building. The group then inspected the modern wood testing and treating facilities of the forestry department, the tire and plow testing machinery of the USDA Tillage Machinery Laboratory, and the new agricultural engineering farm, all of which are located on property of the Alabama Agricultural Experiment Station.

Lawrence Ennis, Jr., of the Alabama Agricultural Service, welcomed the group and a response was made by M. B. Penn of the Alabama Power Co. These addresses were made during the luncheon which was served in the agricultural engineering annex.

The afternoon program opened with a summary of "Experimental Activities in the Farm Machinery Field," by C. M. Stokes and T. E. Corley of the Alabama station. The newest developments in peanut and cotton harvesting and production were shown on the screen and explained. A one-hour panel on "Artificial Curing of Crops," led by H. W. Dearing, agricultural engineer, Tennessee Coal, Iron and Railroad Co. pointed out through slides and movies the progress, importance, and the factors involved in artificial curing. First-hand experiences were re-

### A.S.A.E. Meetings Calendar

- December 19 to 21 — WINTER MEETING, Stevens Hotel, Chicago, Illinois
- January 28 — IOWA-ILLINOIS SECTION
- February 9-11 — SOUTHEAST SECTION, Buena Vista Hotel, Biloxi, Miss.
- March 16 and 17 — PACIFIC COAST SECTION, Logan and Salt Lake City, Utah
- June 19-21 — ANNUAL MEETING, Statler Hotel, Washington, D. C.

lated by panel members E. S. Dorsey, Dorsey Stock Farms, Opelika; Jake Jewell, seedsman, Orrville; and J. L. Butt, assistant agricultural engineer, Alabama station. A short business meeting concluded the afternoon session.

The banquet program featured a series of short talks designed to give the ASAE student members present an insight into various agricultural engineering activities. The program was prepared and introduced by F. A. Kummer, head of the agricultural engineering department, Alabama Polytechnic Institute, who first introduced two students, Luther Cox and J. D. Morris, Jr., who discussed "Agricultural Engineering As I See It." Next R. E. Jezek, USDA Tillage Machinery Laboratory, discussed "Agricultural Engineers in the Government Service." Following Mr. Jezek, C. A. Rollo, Grimes Tractor and Implement Co., Montgomery, discussed "Agricultural Engineers in Sales Work." T. L. Sanderson, Alabama Extension Service, described "The Duties of Agricultural Engineers in Extension Work." C. H. Bailey, Brierfield, talked on "Agricultural Engineers on the Farm," and C. D. Weldon, Alabama Power Co., Birmingham, covered "Agricultural Engineers in the Utilities Service."

It was decided that the next meeting would be held at Gulf Shores, Alabama, at a date to be decided later.

### Chicago Section Elects

**A**T A meeting held Tuesday, November 15, at the Corn Products Refining Co. plant near Chicago, the Chicago Section of the ASAE elected H. F. Carroll as its chairman for the following year. The new vice-chairmen are Earl D. Anderson and John H. Wessman. Thomas E. Long was elected secretary.

A plant tour was the opening feature of the meeting. It was followed by a lunch as guests of the company. After the lunch and business meeting, the group was addressed by Wheeler McMillen, editor-in-chief of *Farm Journal*, and president, National Farm Chemurgic Council. He briefly reviewed the nature and significance of the chemurgic program and reminded the agricultural engineers of their part in it, related to the handling of farm products so that processors can use them as raw material for more non-food products helping to make it economically feasible for farmers to raise new crops and improving the economy of using crop plant parts now classified as residues or wastes.

Dr. Henry Cox, director of the chemical division of Corn Products, and some of his associates spoke briefly on their production operations and research program. They then showed the group through the chemical research and pilot plant laboratories.

More than 60 members and guests of the Section attended.

(News Continued on page 594)



F. A. Kummer presiding at ASAE Alabama Section banquet



For the best in electrical farm equipment—G-E equipment—buy where you see this sign.

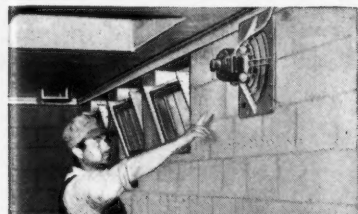
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The General Electric fan motor is rubber-mounted to assure quiet operation. Galvanized metal body, aluminum fan blades, bronze motor bearings, and fully-enclosed motor housing protect the ventilator against rust and corrosion. For additional information, check "Barn Ventilator" on the coupon.



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A new "packaged" jet water system specifically designed for use on shallow wells is now on the market. An outstanding feature is the use of new-type seals which eliminate wear rings and prevent leakage. The pump is water-lubricated and never needs oiling or greasing. It is driven by a heavy duty, drip-proof General Electric motor,  $\frac{1}{2}$  or  $\frac{3}{4}$  hp. For additional information, check "Jet Pump" on the coupon.

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## Cleans two milkers at a time in less than 10 min.; prevents milkstone, helps keep bacteria count low

Dairymen are now learning about a new electrically-driven milker washer which is said to save an hour of their time a day, besides giving them valuable help in keeping bacteria count low. With this new washer, it is no longer a difficult time-consuming job to keep bacteria-harboring milkstone from forming on the inside of milking machines. By circulating water and a bacteria-killing detergent through the milker, this washer thoroughly cleanses every part, crack, and crevice touched by the milk.

### Easy to use!

It gets rids of the daily chore of taking apart, scrubbing, and reassembling milkers. The user simply attaches one or two milkers to the washer, flips a switch, and in less than 10 minutes, the milkers are clean and sanitary.

The washer can be used on any make of milking machine. There are eight teat cup hoods, sufficient for two single milking units at a time. Cool or warm water is used. The washer pump is driven by a General Electric motor.

### Likes 1, buys 4 more!

Earle Machold of Ellisburg, N. Y., who maintains a large herd of purebred Holsteins, installed one of these washers and found it was such a timesaver that he bought four more. For additional information, check off "Milker Washer" on the coupon below.

## Here's A Tip On How To Keep A Poultry House Dry

Here's the quick, easy, and inexpensive way to ventilate your poultry house. Keep litter drier, birds healthier with this General Electric fan kit with unit-bearing motor. Moreover, these fan kits can save valuable layers during summer heat spells by keeping poultry houses cool.

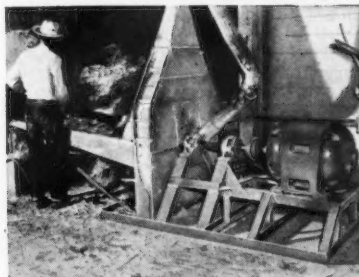
This fan has a 10-inch blade, moves 360 cubic feet of air per minute. It is driven by a 9-watt G-E unit-bearing motor, totally enclosed to keep out dirt. The one-piece, cast iron housing keeps the bearing permanently aligned. Easily installed. Ventilating fan, complete with cord, mounting bracket, and bolts — \$9.95.



Robert Cobb, unit manager for the Machold Farms, says automatic washers make it easy to keep milkers clean, bacteria count low.

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"Reliable? It's never let us down," says Marlin Hendricks, manager of the Frank de Benedetti Ranch near Oakdale, Cal. about his rugged multi-crop feed mill. "After four years of constant service, eight to twelve hours a day, seven days a week, we're sold on our mill and its General Electric Tri-Clad motor." Not only does the mill help cut grain and hay waste to an absolute minimum, but it saves a lot of back-breaking labor. For additional information, check "Feed Mill" on the coupon.



The grinding action of this mill gets rid of sharp pointed hay stems.

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## NEWS SECTION (Continued from page 592)

### Wheeler New Chairman of Tennessee Section

**WILLIAM C. WHEELER**, associate professor of agricultural engineering, University of Tennessee, was elected the new chairman of the Tennessee Section of the American Society of Agricultural Engineers at its fall meeting held at Knoxville, Tenn., on November 5, succeeding J. C. Hundley. Other officers elected included the vice-chairman, R. C. Hines, agricultural engineer, Tennessee Valley Authority, and the secretary-treasurer, Edwin J. Matthews, assistant professor of agricultural engineering, University of Tennessee.

The meeting, held on the University of Tennessee campus, presented a very interesting program. Talks were given by J. N. Maroney, farm products research, John Deere & Co., L. A. Hawkins, farm practice research, International Harvester Co., and Ed Holt, local branch manager, International Harvester Co.

### Pacific Coast Section Meets in March

**THE** next meeting of the Pacific Coast Section of the American Society of Agricultural Engineers will be held at Logan and Salt Lake City, Utah, March 16 and 17. The program now being arranged will report progress in agricultural engineering research and applications toward solving problems and advancing efficiencies in western agriculture, giving special attention to soil and water conservation and management, power and machinery, and farm structures. It is planned to summarize the most up-to-date information from eight of the western states in which agricultural engineering research and applications are most active.

The soil and water conservation portion of the program will include the following subjects: solving drainage problems in California barrier areas, cooperative research in western irrigation agriculture, canal lining research—problems and progress, technical irrigation guides in soil and water management, irrigation of range lands of water spreading, irrigation by sprinkling—why and where, infiltration on characteristics of slick spot areas, and progress in soil and water management—research, education, and action.

Further details of the program will be announced later.

### Georgia Section Fall Meeting

**THE** fall meeting of the Georgia Section of the American Society of Agricultural Engineers was held in Athens, October 29, with J. W. Simons, chairman, presiding. The program, with G. E. Henderson as chairman, was brief but extremely interesting to the 42 members attending. Highlights of current research being conducted by the agricultural engineering department of the University of Georgia in cooperation with the U. S. Department of Agriculture and other agencies were illustrated. Research subjects illustrated were tobacco curing by J. M. Stanley, supplemental irrigation with emphasis on anhydrous ammonia application by W. B. Land, and the construction and operation of the new peanut combine by W. D. Kenney.

An inspection tour of other research projects was made. W. E. Garner explained the construction and operation of equipment for meat-curing studies. A demonstration of the newly developed farm fence post peeler was given by G. L. Chavous, R. J. McCraney demonstrated machines for green pea and bean shelling as well as a fresh corn cutter. Seed corn drying studies were explained and demonstrated by L. L. Smith. D. T. Kinard reviewed the studies on egg cooling and demonstrated farm and commercial size model coolers on which studies are being made.

The group decided that the spring meeting should be held about 25 miles out in the Gulf of Mexico to continue the "deep research project" started some three years ago.

### New Series of A-E Textbooks

**ANNOUNCEMENT** of the Ferguson Foundation Agricultural Engineering Series textbooks was made in October by John Wiley & Sons, book publishers.

The new series of books is being sponsored by the Ferguson Foundation, Detroit, to help advance the agricultural engineering profession. Publications in the series will be junior and senior-level college textbooks, very much needed in American educational institutions at present. In addition to furnishing necessary information to students, the books offer considerable assistance to instructors in raising the level of agricultural engineering instruction.

To begin the series, Wiley will publish "Farm Structures," by H. J. Barre and L. L. Sammett, in January, 1950. Developed as a project of the Purdue University Agricultural Experiment Station in cooperation with the Ferguson Foundation and Purdue Research Foundation, the book presents the technical details necessary for an engineering approach to farm structures problems. H. J. Barre is professor of agricultural engineering at Purdue University, while L. L. Sammett, former-

ly an associate of Barre at Purdue, is now with the University of California Agricultural Experiment Station at Berkeley.

Future volumes in the series will deal with power and machinery, processing of farm products, and farm operations.

### California A-E Curriculum ECPD Accredited

**MANY** agricultural engineers will rejoice with staff members of the division of agricultural engineering, University of California, Davis, in the good news that the institution's professional curriculum in agricultural engineering has just been accredited by the Engineers' Council for Professional Development (ECPD).

Heretofore the curriculum was accredited as an option in mechanical engineering, but recently the division has set up its own curriculum and on re-examination of the curriculums offered by the University's engineering school, agricultural engineering was accredited as a separate and distinct curriculum.

### USDA Cotton Ginning Lab Dedicated

**DEDICATION** ceremonies for the new U. S. Cotton Ginning Branch Laboratory at Las Cruces, N. M., will be held on the campus of the New Mexico A. and M. College at Mesilla Park on December 17. Featured speaker on the program will be Senator Clinton P. Anderson of New Mexico who was Secretary of Agriculture at the time plans for the new laboratory were initiated.

Cotton growers throughout the Southwest, as well as representatives of various groups in the cotton industry all over the South, have been invited to attend. Investigations at the new laboratory will be concerned primarily with cotton-ginning problems peculiar to the region that includes New Mexico, Arizona, Texas, and California, especially to irrigated areas.

In addition to the address by Senator Anderson, the program for the dedication will include welcoming talks by Governor Thomas J. Mabry of New Mexico and President J. W. Branson of the New Mexico A. & M. College with a response by Assistant Secretary of Agriculture Knox T. Hutchinson. Brief addresses also will be made by Horace Hayden, executive vice-president of the National Cotton Ginners' Assn.; Harold Young, president of the National Cotton Council; Omer Herrmann, assistant director of the Agricultural Research Administration, and J. I. Thompson, assistant director of the Production and Marketing Administration, both in the USDA.

The new laboratory will operate as a branch of the basic U. S. Cotton Ginning Laboratory at Stoneville, Miss. It is one of the research units of the Department of Agriculture made possible by the Research and Marketing Act of 1946.

### Oklahoma A-E Staff Additions

**RECENTLY** the agricultural engineering staff of the Oklahoma A. and M. College announced the following additions: James A. Gar-ton, who recently completed his work for a master's degree in irrigation at Utah State Agricultural College, is one of the new members of the staff. John J. McDow, with a master's degree in agricultural engineering from Michigan State College, will be doing teaching and research work in farm power machinery. Elmer R. Daniel, a graduate of Oklahoma A. & M. and more recently with TVA and the Oklahoma extension service, will be handling rural electrification work. George W. A. Mahoney, a graduate of the University of Illinois, will be doing teaching and research work in farm structures. Also two graduate fellows on the staff are J. W. Autry, an A. & M. College of Texas graduate on leave from Tarelton College where he is associate professor of agricultural engineering, and Edd Rhoades on leave from the U. S. Soil Conservation Service.

### Brooks Named Research Lecturer

**DR. FRED A. BROOKS**, professor of agricultural engineering, University of California, has been named Faculty Research Lecturer for 1949-50, for the branch of the University at Davis. He is the second successive agricultural engineer to be so honored, Dr. Frank J. Veihmeyer having been named for the past year. The lecture is delivered as a feature of Charter Week ceremonies of the University in March.

Dr. Brooks is a native of Minneapolis, Minn. He earned his bachelor of science degree at the University of Illinois in 1917; his master of science degree in 1919 and his doctor of science degree in 1920 at the Massachusetts Institute of Technology; and his professional degree (mechanical engineer) at the University of Illinois in 1927. During the academic year of 1922-23 he filled a temporary appointment as a teaching fellow at the University of California. Between 1917 and 1931 he was engaged in engineering design and research with various commercial organizations. Since 1931 he has been with the agricultural engineering division of the University of California, as associate agricultural engineer, associate professor, and professor.

Research fields in which he has made notable contributions include the abrasiveness of silica and carbonate (Continued on page 596)

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• From 1939 until today—its Tenth Anniversary—Ferguson has been the pace setter for the industry. Notwithstanding a major world conflict, *over forty outstanding implements* were introduced into the Ferguson line in this short period!

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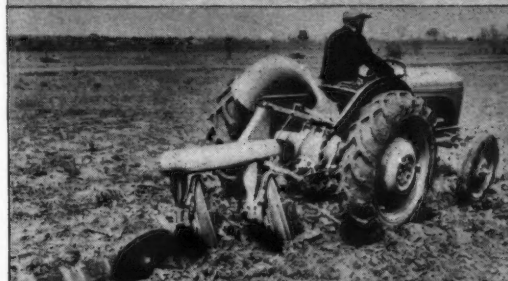
You'll agree—The Line with the Future is...  
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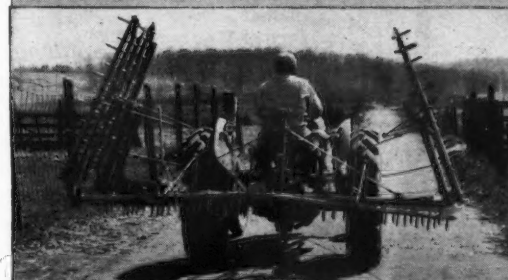
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2. Ferguson's new Manure Spreader and Loader. A one-man, one-tractor combination. Spread and load all day without leaving tractor seat.



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4. Ferguson's new Spike-Tooth Harrow. Four section, ends fold for gate clearance. Specially designed for high-speed tractor operation.

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## NEWS SECTION (Continued from page 594)

particles influencing the wear of automotive parts, problems of orchard heating, and more recently surface climatology, with particular reference to heat exchange between soil and atmosphere. He has frequently served as a consultant to the U. S. Navy on problems of climatology.

A member of the American Society of Agricultural Engineers since 1934, Dr. Brooks has subsequently been elected to the grade of Fellow, and has contributed to committee work and various programs of the Society and its Pacific Coast Section. One of his significant contributions was his address before the Society at its annual meeting in 1947 on the subject of "Research Procedures for Cooperative Projects with Limited Personnel" (AGRICULTURAL ENGINEERING, October, 1947).

### Personals of A.S.A.E. Members

*Albert L. Brodie*, until recently technologist in the Chicago office of The Texas Co., has been transferred to the company headquarters in New York City to become assistant director of technical service.

*T. H. Oppenheim* recently resigned his position in charge of engineering and research of the New Idea Division, AVCO Manufacturing Company. He was elected director and secretary of the New Idea Company in 1920 and in 1940 was appointed plant manager. He held these positions until acquisition of the company by AVCO Manufacturing Corporation when he took charge of engineering and research. His plans for the future have not been announced.

### Necrology

*WALTER W. CARSON*, manager of rural service, West Penn Power Co., passed away November 14. He had been ill for several weeks.

Mr. Carson was born in Uniontown, Pa., in 1888. A graduate of Washington & Jefferson College in 1913, he joined West Penn as a salesman at Monongahela in 1918. He was appointed district manager there in 1922, and continued at that post until 1937 when he was transferred to Pittsburgh and promoted to the position he held at the time of his passing.

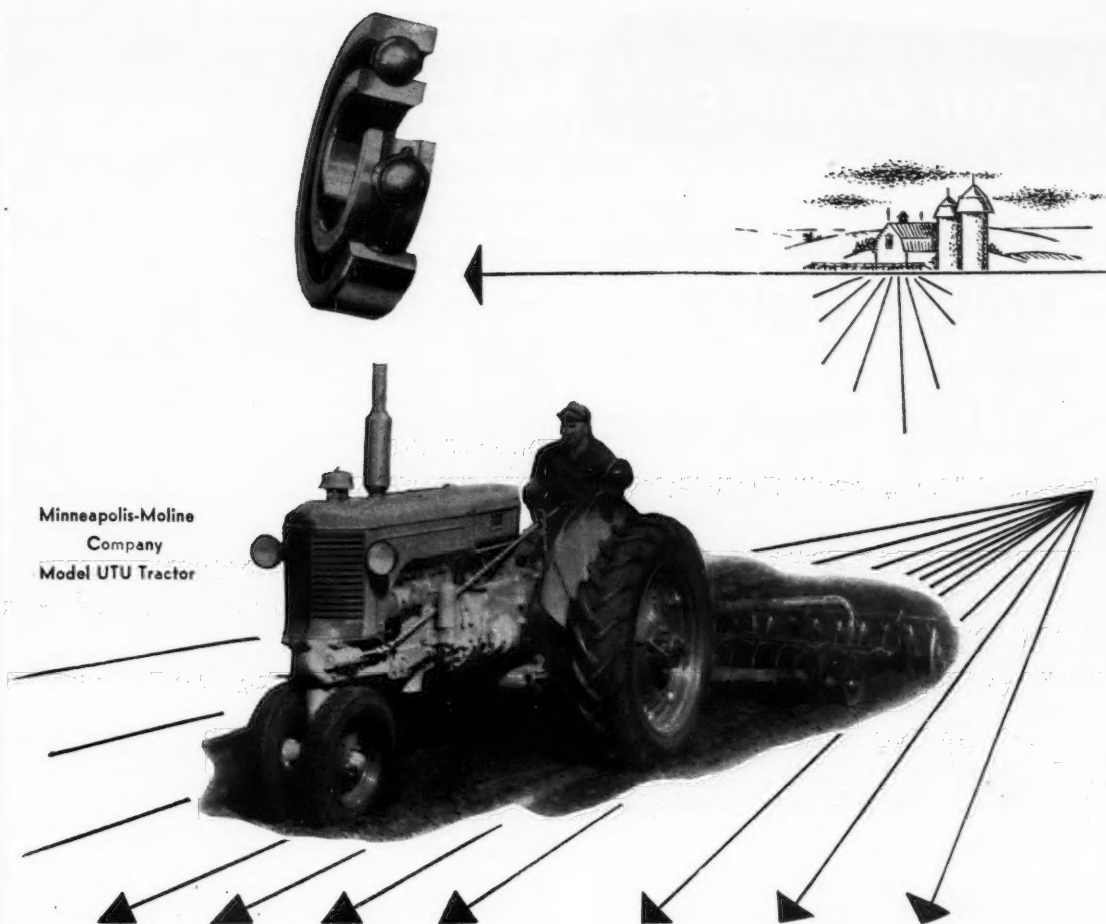
Mr. Carson was well known in the rural areas of the state because of his activities in introducing improved farming methods. In September he had been elected chairman of the Pennsylvania Section of the American Society of Agricultural Engineers. He was a member of the farm committee of the Electric League of Western Pennsylvania. He had been a member of the Society since 1945. He was also a member of the board of governors of the City Farmers Club of Pittsburgh, a member of the Agricultural Committee of the Pittsburgh Chamber of Commerce, and of the Farm Utilization Committee of Edison Electric Institute.

Mr. Carson was a member of Monongahela Lodge F. & A. M., the Consistory and Syria Temple at Pittsburgh, an elder in the Mt. Lebanon United Presbyterian Church, and a member of the Tuesday Noon Club of the First Presbyterian Church, Pittsburgh. He is survived by his widow, Anne Risher Carson, three daughters, and a son.

*HOWARD C. LISLE*, vice-president in charge of agricultural divisions, Food Machinery and Chemical Corp., passed away at Lansing, Mich., October 12, at the age of 64. Born at Panora, Iowa, in 1885, he grew up in California and started work in the farm equipment business on Saturdays and during vacations while in high school, working for the Anderson-Barngrover Co. of San Jose, Calif. After 1½ years at Stanford University he entered the sales department of the John Bean Spray Pump Co. He remained with the Bean organization throughout his career, being promoted successively in charge of the Northwest and Rocky Mountain territory in charge of the Midwest and Rocky Mountain territory, manager of the branch factory at Lansing, Mich., and to vice-president of the Food Machinery organization in 1946. During these years he contributed actively to the engineering design and development of various items in the Company's line of products. He had been a member of ASAE since 1926, and at the time of his passing was also a director of the Farm Equipment Institute.

*JOHN A. SCHALLER*, advertising manager, Rilco Laminated Products, Inc., passed away Tuesday, November 8 at Miller Hospital, St. Paul, Minn., after a brief illness. He was born at Barneveld, Wis., April 4, 1906, and was a graduate of the University of Wisconsin, where he received bachelor's degrees in agriculture in 1930 and in electrical engineering in 1931. For several years following his graduation he was engaged in erosion control work in Wisconsin. From there he went to the Tennessee Valley Authority, where he was employed for 10 years, with promotions to head of the research section, agricultural engineering development division. In 1946 he resigned that position to become advertising manager of the Rilco organization. Mr. Schaller had been a member of the American Society of Agricultural Engineers since 1934 and was also a member of the St. Paul Advertising Club. He is survived by his wife, Ella Jane, two daughters, his father, six brothers and five sisters. Interment was at Mt. Horeb, Wis.

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Company  
Model UTU Tractor



**plow! harrow! drill! combine! cultivate! till! tend!**

## **the tractor that runs smoother on SKF bearings**

Spring planting and plowing really give a tractor a workout, and farmers know the need for a dependable, day-in-day-out working unit. To help insure this, the Minneapolis-Moline Tractor is equipped with SKF Bearings.

These bearings are designed and manufactured by SKF bearing experts to withstand the shock of severe operation with a minimum of operator attention and

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No wonder manufacturers of tractors and mechanized farm equipment prefer SKF Bearings. Our engineers can help with your bearing applications. SKF Industries, Inc., Philadelphia 32, Pennsylvania.

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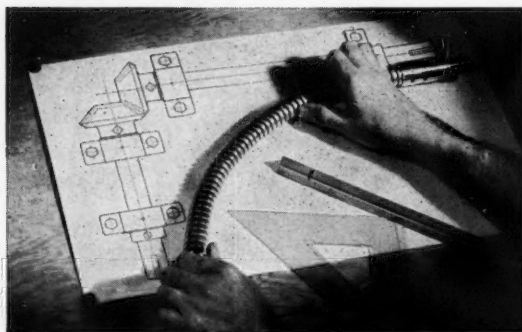
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## LETTERS TO THE EDITOR

### "Engineering for the Small Manufacturer"

TO THE EDITOR:

**M**AY I congratulate you on your editorial, entitled "Engineering for the Small Manufacturer", in the October, 1949, issue of AGRICULTURAL ENGINEERING.

I have had considerable experience, first as an engineer for a parts supplier and later as an engineer for a sizable machinery purchaser, and if there is anything that I can attribute to this experience it is the conviction that a manufacturer, large or small, has at his disposal an immense amount of engineering talent other than that on his staff.

The suppliers of basic farm implement parts (power transmission components, power units, wheels, bearings, etc.) all have adequate sales engineering facilities, and engineering assistance is now a universal part of the bill of goods sold to the manufacturer.

There is another very important source of engineering information. This is the purchaser of the finished piece of equipment. I have never seen more effective development facilities than the farms of machinery purchasers. I do not mean to imply that the small manufacturer should victimize his customers by using them to provide free proving grounds. I refer to the splendid cooperation given by intelligent farm management in permitting small manufacturers to try out their equipment under the conditions of his own peculiar problems. In fact, I believe you will find that California abounds in small manufacturers of farm equipment whose business has grown out of the specialized requirements set up by individual farmers.

To sum up the whole idea, engineering need be no problem to a small manufacturer if on the one hand his clients will define the duties of a yet-to-be-built machine, and on the other hand the suppliers of the components of that machine will provide no more than customary sales engineering.

Agricultural engineer  
Spreckels Sugar Company

AUSTIN ARMER

### Design Tractor Controls for Safety

TO THE EDITOR:

**S**OME of our most serious farm accidents result from tractors going out of control and turning over. There has been a lot of controversy over automatic devices to shut off the engine in times of emergency. However, the best device we have for keeping a tractor in control is the operator's good judgment and quick reaction.

Manufacturers are not giving tractor operators a chance to use their reactions safely. There is lack of uniformity of tractor controls. Several tractors lack a provision to lock the rear brakes together easily and quickly so they may be applied evenly during travel at road speeds. Some models have controls which are difficult to reach and manipulate.

Snap reaction has saved many a life. The ability to reach the proper control and move it in the right direction in a split second has often meant the difference between a close shave and a disaster. Yet here is what we find on our tractors: to decrease engine speed on some models the throttle lever is pulled back; on others it must be pushed forward. The same non-uniformity can be found in hand clutches. A motion which will stop one tractor will cause another to start.

Now this confusion would not affect the farmer who owns and drives only one tractor, but with more than one tractor on many farms, and with exchange of work, most farmers and hired men drive all makes and models at some time or other. In an ordinary operation and with plenty of time to think, the tractor operator can get a tractor slowed down or stopped, regardless of what control he may be used to. But once in a while there is an emergency; a deep ditch, a tile hole, or a crisis on the highway when there just is not time for all those mental gymnastics. Then the split second reaction of moving the control in the wrong direction causes a serious accident.

Automobile manufacturers just could not sell a car that lacks four-wheel brakes. With the fast road speeds we now have in tractors, farmers should at least demand for their tractors good two-wheel brakes which can be applied by the same control. Anyone who has tried applying simultaneously a separate brake for each wheel knows that it cannot be done evenly and safely, particularly in case of an emergency. In a split second reaction the operator is very apt to apply the brakes unevenly or brake only one wheel, causing the tractor to veer or turn over.

Standardization of tractor controls will probably never be complete. For example, there are those who prefer a hand clutch to a foot clutch, and vice versa. However, all hand clutches could be made to stop the tractor when they are pulled back. All throttle levers could be designed to slow down the engine when they are pushed forward. Certainly both rear wheel brakes can be made to lock

(Continued on page 600)

# NEW

## BLAW-KNOX PRODUCTS FOR THE FARM

- ★ UNIVERSAL STEEL BUILDINGS
- ★ UNIVERSAL CROP DRIER
- ★ CROP CONDITIONER
- ★ PASTURE BUILDER



Blaw-Knox Universal Building used to dry corn, with Crop Drier System installed inside. Weatherproof, fire-resistant construction of the all steel building and the insulated interior offer excellent crop storage facilities.



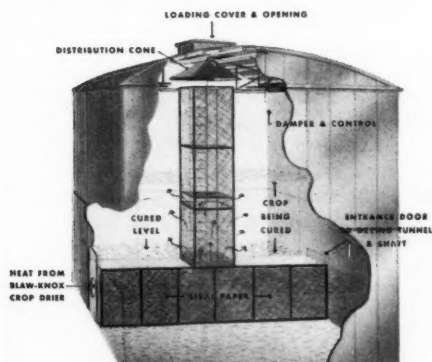
Blaw-Knox Crop Drier installed outside a Universal Building. Relatively inexpensive to install and operate, this unit pays for itself in quality crops that command top market prices.



Interior of Universal Building arranged for dairy barn. Without the stanchions, this building can also be used for beef cattle. Versatility in arrangement of standard panels permits adaptation for any size or purpose.



The Blaw-Knox Pasture Builder is a new farm tool for building productive grass-legume pastures from poor, worn out meadows. Elements are interchangeable, adjust automatically to contour of the land.



AS CURING LEVEL RISES SIGAL PAPER OR OTHER SIMILAR MATERIAL IS APPLIED TO INTERIOR OF OPEN MESH FRAMES

Blaw-Knox Crop Conditioner—the answer to the critical problem of storing and conditioning grain and forage crops. Built of Universal Building standard parts, the interior air shafts are removable to make a low cost storage unit. An economical conditioning building is possible with the use of air shaft and tunnels for passing air through the product to be dried.

**H**ERE'S a new name in the farm field—*Blaw-Knox*—with a new line of time and money saving equipment. The Blaw-Knox Universal Crop Drier is the answer to crop drying problems under any weather conditions . . . does a thorough drying job on corn, hay, small grain, soy beans, etc. Ideal for processing seed crops.

Blaw-Knox Universal Buildings, all steel and fully insulated, are assembled of standard panels to meet every farm building requirement . . . warehouses, poultry houses, seed processing plants, feed storage, machinery storage, dairy barns, crop drying sheds, workshops, etc.

Ask for full details and literature.

UNIVERSAL BUILDING DEPARTMENT

**BLAW-KNOX DIVISION**  
of BLAW-KNOX COMPANY

P. O. Box 1198, Pittsburgh 30, Pa.

## WINTER TIME *Isn't* STORAGE TIME



for this  
**WISCONSIN**  
Powered Tiller!

Slicing out a two-foot path with its easily attached rotary plow . . . then blowing the snow as far as 18 feet away is the winter-time task of this Wisconsin Heavy-Duty Air-Cooled Engine powered Ariens Tiller.

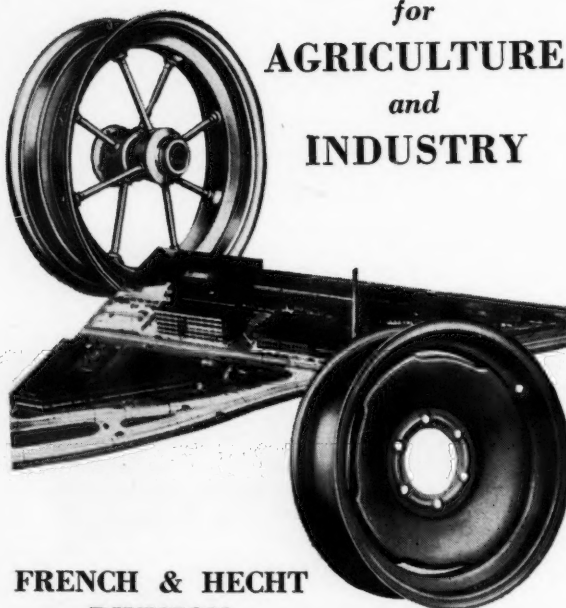
Equipment builders and buyers alike rely on Wisconsin Engines for power tasks 3 to 30 hp., winter and summer, on farms everywhere. A reputation staked on a Wisconsin Engine is a well-founded confidence in such dependable features as self-cleaning, thrust-absorbing Timken tapered roller bearings . . . fool-proof air-cooling, from sub-zero to 140° F. . . an easily serviced rotary-type OUTSIDE magneto with impulse coupling, for any-weather quick starting . . . and heavy-duty construction throughout. Write for detailed data. 4-cycle, single-cylinder, 2-cylinder, and V-type, 4-cylinder models, 3 to 30 hp.



## F & H WHEELS

for

AGRICULTURE  
and  
INDUSTRY



**FRENCH & HECHT  
DIVISION**

**KELSEY-HAYES WHEEL COMPANY  
DAVENPORT, IOWA**

*Wheel Builders Since 1888*

## Letters to the Editor

(Continued from page 598)

together and operate from the same lever or pedal. Making the controls easy to reach, easy to handle, and uniform would give the operator the best chance of stopping the tractor during a turnover or other emergency.

The National Safety Council, the ASAE Committee on Farm Safety, and tractor manufacturers could save limbs and lives by attacking this problem and improving the design of tractor controls for safety.

J. A. WEBER

Research assistant  
Agricultural engineering department  
University of Illinois

## Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

*Ali, Syed Aejaz*—Graduate student in agricultural engineering, Iowa State College, Ames, Iowa

*Barton, Harry F.*—Rural supervisor, St. Joseph Light & Power Co., 514 Francis St., St. Joseph, Mo.

*Bodri, Joseph S.*—Agricultural engineer, Soil Conservation Service, USDA. (Mail) 18th Floor Court House, Reading, Pa.

*Bobannon, E. B., Jr.*—830 North 5th Ave., Knoxville, Tenn.

*Bondurant, Byron L.*—District agricultural engineer, New York State College of Agriculture. (Mail) Abbott Road, R. R. 1, Hamburg, N. Y.

*Brenner, Nevin T.*—Chief fuels and lubricants engineer, tractor section, Gulf Oil Corp., Gulf Bldg., Pittsburgh 30, Pa.

*Brinkmeyer, Francis M.*—Product engineer, John Deere Wagon Works, Plant No. 2, Moline, Ill.

*Brown, Robert H.*—Associate professor of agricultural engineering, University of Georgia, Athens, Ga. (Mail) 597 Morton Ave.

*Bush, Edward H.*—Associate county agent, extension service, A. & M. College of Texas. (Mail) Agricultural Bldg., Texas Tech, Lubbock, Tex.

*Campbell, H. W.*—Manager, farm equipment dept., M. G. Newell Co., 323-325 S. Davie St., Greensboro, N. C.

*Dasenbrock, J. Henry*—Export service manager, Harry Ferguson, Inc. (Mail) 21421 Sloan Ave., Detroit 24, Mich.

*El-Kashef, Ali Fahmi*—School of civil engineering, Cornell University, Ithaca, N. Y. (Mail) 201 College Ave.

*Eggers, Henry W. T.*—Departmental engineer, New Zealand Department of Agriculture, P. O. Box 3004, Wellington, New Zealand.

*Eichenberger, W. N.*—Engineering dept., Massey-Harris Co., Ltd., Toronto, Ontario, Canada (Mail) 222 Coxwell Ave.

*Garland, J. W.*—Research assistant in agricultural engineering, North Dakota Agricultural College, Fargo, N. D.

*Gilchrist, David M.*—Assistant, Agricultural Engineering Service, New Brunswick Department of Agriculture, Fredericton, N. B., Canada.

*Graves, Jack L.*—Summit Circle, Knoxville, Tenn.

*Gregory, Richard M.*—Graduate assistant in agricultural engineering, Purdue University, West Lafayette, Ind. (Mail) 100 South St.

*Hazlewood, M. B., Jr.*—Sales engineer, J. D. Pittman Tractor Co., 500 N. 28th St., Birmingham, Ala.

*Jessop, R. B.*—Chief mechanical engineer, Western Province Groundnut Scheme, Overseas Food Corp., Tanganyika Territory, British East Africa. (Mail) P. O. Urambo Station.

*Lewis, A. B.*—Instructor in agricultural engineering, Lincoln University, Jefferson City, Mo.

*Maxwell, Elwood R.*—R. R. No. 4, Paris, Tenn.

*Miller, Lippman*—Sales and service, Manning W. Howell. (Mail) c/o Billings, 5739 Merle Hay Rd., Des Moines, Iowa

*Milligan, D. C.*—Assistant agricultural engineer, Nova Scotia Department of Agriculture, Truro, Nova Scotia.

*Neville, John G.*—Technical assistant, Electricity Supply Commission of Southern Rhodesia, Box 377, Salisbury, S. Rhodesia.

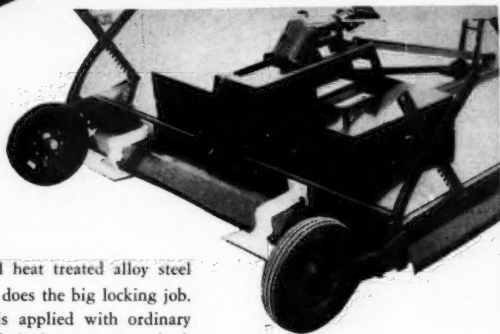
*Norton, Phil*—Sales manager, Wisconsin Motor Corp., 1910 S. 53rd St., Milwaukee 14, Wis.

*Powers, Mitchell R.*—Associate agricultural engineer, Edisto Experiment Station, Blackville, S. C.

(Continued on page 602)



# Security LOCKNUTS USED EXCLUSIVELY IN STALK PULVERIZERS



The elliptical heat treated alloy steel retainer ring does the big locking job. As locknut is applied with ordinary wrench, the bolt forces retainer back into ROUND. This causes retainer to grip bolt threads with high tension strength, preventing nut from rotating.

The Stalk Pulverizer is made by Wood Bros. Mfg. Co., Oregon, Ill. It operates on a direct power take-off from the tractor.

**Owing to its high speed service, this machine is subjected to severe vibration, but the Security Locknuts stay put because of positive, dependable, automatic locking.**

Security Locknuts are doing an outstanding job of fastening high speed equipment. Because of positive locking safety — exact nut adjustment — speed and economy of application — locking power never lost or threads or bolts injured, Security Locknuts have a very definite value to manufacturers of farm machinery.

1. You add greatly to the safety of your equipment
2. You increase the dependability of your equipment
3. You save maintenance costs for your customers
4. You save on your own production costs
5. You are better able to meet competition



**SECURITY LOCKNUT**  
CORPORATION

1815 N. Long Avenue

Chicago 39, Illinois

**Free Sample** Write on your letterhead, giving your title and a sample nut will be sent to you at once. There is no obligation on your part.

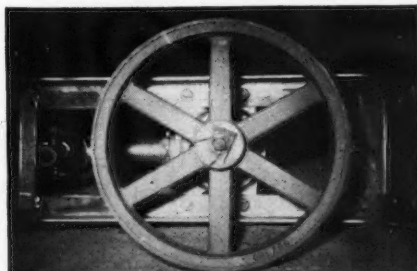


● Illustration shows convenience of sub assembly by power wrenching.



● The Stalk Shredder has two blades operating on a horizontal plane at 1300 r.p.m. The safety provided against vibration here indicates the possibilities for this safety in your equipment.

Every nut on the Stalk Pulverizer is a SECURITY LOCKNUT.



★



## Specify... TUTHILL MODEL 5-W

**The Pump for Your  
Weed and Pest  
Control Equipment**

No other pump for tractor spraying outfits combines these practical advantages of the Tuthill Model 5-W in one compact unit:

- Direct-mounted on power take-off.
- Adaptable to pulley drive.
- Compact . . . close-coupled design. Over-all dimensions . . . 4½" x 5½" x 6½" . . . Net weight 12½ lbs.
- Fits 1¼" or 1½" spline shafts.
- Pressure range from 0 to 150 pounds per square inch.
- Delivers 5 g.p.m. at 100 p.s.i. at 550 r.p.m.; 16 g.p.m. at 100 p.s.i. at 1750 r.p.m.
- Built of highly corrosion-resistant materials to handle a wide variety of spray liquids.
- Self-priming . . . self-lubricating.

Write for complete details.

### TUTHILL PUMP COMPANY

939 East 95th Street . Chicago 19, Illinois . Phone RE 4-7420

## EWG WHEELS

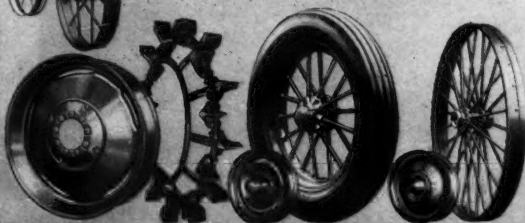
### Designed to do the Job

For more than fifty years we have built dependable steel wheels for movable equipment . . . agricultural and industrial.

You can rely on EWG engineers to recommend the correct wheels for your unit. This is particularly valuable when new machines or new models are being considered.

If one of our standard wheels is not the most efficient, we can design and manufacture special wheels.

**Write for our catalog**



**ELECTRIC WHEEL CO., 2908 Pine, Quincy, Ill.**

## Applicants for Membership

(Continued from page 600)

Reed, Edward B. — Insulation engineer, Capitol Home Insulation Co. of Trenton, Trenton, N. J. (Mail) 821 E. State St.

Rissmiller, Willard F. — Assistant extension agricultural engineer, Purdue University, West Lafayette, Ind.

Slick, Fred S. — Assistant manager, magneto div., J. I. Case Co., Rockford, Ill.

Somerhalder, Bertrand R. — Assistant in irrigation research, agricultural engineering dept., University of Nebraska, Lincoln 1, Nebr. (Mail) 848 North 14th.

Stone, Russell B., Jr. — Agricultural engineer, Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA. (Mail) P. O. Box 437, Springfield, Tenn.

Wallin, Robert E. — Student engineer, New Holland Machine Div., The Sperry Corp., New Holland, Pa. (Mail) 223 Hillcrest Ave.

White, Finnie E., Jr. — Graduate student in agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Va. (Mail) c/o Mrs. W. H. Byrne, Clay St.

Williams, Claris W. — Salesman, Grimes Tractor & Implement Co., Montgomery, Ala. (Mail) Apt. 14, 411 South Perry

Woodward, Guy E. — Student engineer, New Holland Machine Div., The Sperry Corp., New Holland, Pa. (Mail) 225 Hillcrest Ave.

### TRANSFER OF GRADE

Hart, Harris H. — Manager, technical service, Goodyear Gummi Fabriks Aktiebolag, Norrköping, Sweden. (Junior Member to Member)

Otis, Stanley J. — Electrical control engineer, United Industries, Box 449, Madison 1, Wis. (Junior Member to Member)

Parsons, M. Ray — Instructor in agricultural engineering, California State Polytechnic College, San Luis Obispo, Calif. (Junior Member to Member)

Tribble, Roy T. — Assistant agricultural engineer, Hawaii Agricultural Experiment Station, Honolulu, T. H. (Junior Member to Member)

## Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN: 1949. MAY—O-668, 669. AUGUST—O-34-675, 34-678, 59-680. SEPTEMBER—O-84-681, 84-682, 88-683. OCTOBER—O-109-684, 51-685, 122-686, 121-687, NOVEMBER O-85-689, 127-690.

POSITIONS WANTED: 1949. APRIL W-239, 243, 247, 248. MAY—W-258, 268, 271, 272, 273. JUNE—W-278. JULY—W-288, 291, 292, 294, 296, 297, 299. AUGUST—W-24-304, 60-310, 57-311. SEPTEMBER—W-67-312. OCTOBER—W-90-314, 98-315, 111-316, 113-317, 116-318. NOVEMBER—W-119-319, 125-320.

### NEW POSITIONS OPEN

AGRICULTURAL ENGINEER for research and development work in the soil and water field, with a public service agency in the Tennessee Valley area. Engineering degree and several years experience in research in the soil and water field desired. Usual personal qualifications for research in public service agency. Retirement, annual and sick leave benefits. Salary \$5280, with provisions for automatic increase. O-166-691

### NEW POSITIONS WANTED

DEVELOPMENT, RESEARCH, or teaching work in power and machinery, farm structures, or rural electric field, in public service, preferably in western U. S. A. Family health requires high, dry climate. BS deg in agriculture with major in agricultural engineering, 1939, Michigan State College. Experience in farm management and operation, 8 yr; teaching vocational agriculture part time, 2 yr; education manager for farm equipment distributor, nearly 2 yr. Married. Age 35. No disability. Available on 2 mo notice. Salary \$4300. W-128-321

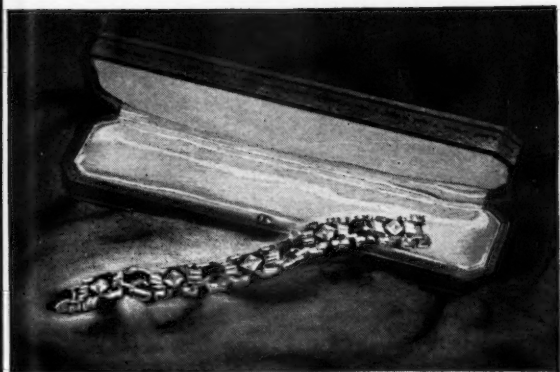
**What other Christmas present  
can you name that...**



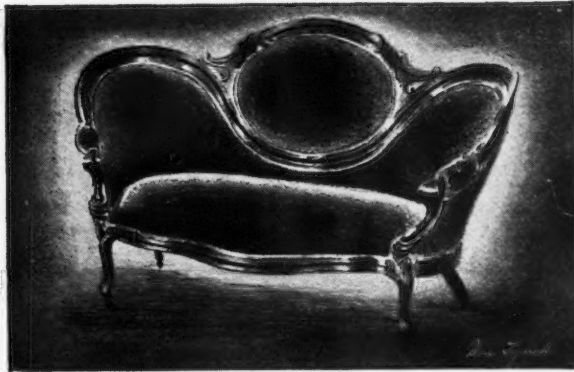
**... you wouldn't want to exchange**



**... comes in so handy on rainy days**



**... never wears out**



**... keeps increasing in value**

**... is so quick and easy to buy  
... pleases everyone on your list  
AND ... gives itself all over again  
(with interest) ten years later?**



**U.S.  
Savings Bonds**

**Automatic Saving is Sure Saving**



*Contributed by this magazine in co-operation with the Magazine Publishers of America as a public service.*

## SPRAYING SYSTEMS

# TeeJet

SPRAY NOZZLES

## The Spray Nozzles Manufacturers Prefer

For Weed Killing, many types of plant pest control, and numerous other farm spraying operations . . . TeeJet Spray Nozzles give the spray uniformity and degree of atomization needed for low cost, effective spraying. TeeJet nozzles are proved in the engineering laboratory and proved in the field.

Get all the facts now . . . see for yourself why the TeeJet line is preferred in its field among spraying equipment manufacturers everywhere. Write for Bulletin 55 . . . describes TeeJet Nozzles and accessory fittings.

**SPRAYING SYSTEMS CO.**  
3226 Randolph St. • Bellwood, Ill.  
(Suburb of Chicago)

## TeeJet Features

✓ Orifice tips and strainers interchangeable without removing body from Boom. Capacities for every application.

✓ Flats on tip parallel to direction of spray for easy nozzle adjustment.



✓ Patented TeeJet "lap edge" spray pattern. Equalizes spray distribution of boom . . . minimizes problem of over-application or missed-areas when boom tilts due to uneven ground.

✓ Uniform particle size for coverage with minimum driftage.

✓ Patented V-Groove tip protects orifice opening against accidental bumping.

✓ Precision construction throughout to make sure that good engineering design is maintained in the manufactured product.

STANDARD EQUIPMENT ON AMERICA'S LEADING SPRAY RIGS AND SPRAYERS

# FARM SALES EXECUTIVE

Corporation with national distribution offers exceptional opportunity to able man with experience and education to fill key position organizing and directing farm sales program. Experience must include farm equipment selling and sound technical knowledge of farm practices. Must be able to build rural dealer organization and devise selling program to keep dealers at top efficiency. We require a good executive who can direct others, yet be capable of conducting effective field demonstrations in person. We seek an ambitious young man who will tackle a big assignment to earn experience and advancement.

**WRITE BOX 12 IN CARE OF  
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### OLSON MANAGEMENT SERVICE

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Tel. State 2601

**RATES:** Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of \$1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

## PERSONNEL SERVICE BULLETIN

(Continued from page 602)

**SALES OR SERVICE** work with private industry in power and machinery, farm structures, rural electric or processing field. BS deg in agriculture 1947, and in agricultural engineering, 1948. Experience in the production of hybrid seed corn, 3 yr; as instructor (research) in agricultural engineering, in a midwestern state college since September 1948. War enlisted service in Army, with 32 mo in European Theater, and promotions to staff sergeant. Married. Age 31. No disability. Available Jan. 1. Salary open. W-152-322

**DEVELOPMENT,** management, service, or teaching work in soil and water field, in a college or private industry, preferably in western U.S.A. BS deg in agricultural engineering, Washington State College. Experience as pump testing engineer, 9 mo. Sales engineer on agricultural, municipal, and industrial pumping systems, 18 mo. War commissioned service over 3 yr, U. S. Marine Corps. Married. Age 27. No disability. Available on short notice. Salary \$4000. W-145-323

**SALES OR SERVICE** work in power and machinery field with manufacturer or distributor, preferably in Midwest. BS deg in agriculture expected Feb. 1, University of Missouri. Farm background and experience in actual operation of farm power equipment. War enlisted service in Army Antiaircraft Artillery over 3 yr, with promotions to technical sergeant. Married. Age 27. No disability. Available Feb. 6. Salary open. W-146-324

**DEVELOPMENT,** management, research, sales, or service in power and machinery or soil and water field, in public service or private industry in U. S.A., Canada, or Europe. BS deg in agricultural engineering expected in January, Oklahoma A and M College. General and tobacco farm background. Apartment building maintenance, 3 yr. Precision inspector, machine parts and final assembly, 2 yr. War enlisted service in Army Air Corps as aircraft armorer, over 3 yr. Married. Age 28. No disability. Available March 6. Salary open. W-151-325

**DEVELOPMENT,** research, or service work in power and machinery field, in public service or private industry in southern U. S. A., or possibly elsewhere. BS degree in agricultural engineering expected Feb. 1, Oklahoma A & M College. Farm background. Prewar experience 3 yr in sales and service with farm equipment distributor. War enlisted service in Navy 4 1/2 yr, with promotion to chief machinist's mate, and including 3 1/2 yr with diesel engines and machine shop. Post-war 6 mo as tool and die maker. Married. Age 31. No disability. Available March 1. Salary \$3000. W-105-326

**DESIGN OR RESEARCH** in power and machinery or soil and water field, with college or manufacturer. Any location. BS deg expected in spring of 1950, University of British Columbia. Single. Age 22. No disability. Available June 1950. Salary \$2400. W-137-327

**EXTENSION,** management, or teaching in rural electric or farm structures field, in a college, preferably in the Southeast or Midwest. BS deg in agricultural engineering, 1947, University of Tennessee. Experience as engineering draftsman in construction field, 2 yr; instructor in vocational agriculture 1 yr; agricultural engineer in rural electrification 1 1/2 yr. Enlisted and commissioned war service in Army Air Force as navigator. Married. Age 30. No disability. Available on 30 days notice. Salary \$4200. W-157-328

**DESIGN,** development, extension, or research in power and machinery or farm structures field in public service or private industry, in Southeast. BS deg in agricultural engineering, 1948, Clemson College. General farm background. Summer vacation employment with U. S. Army Engineer Corps, 4 mo, and Truck Experiment Station, 6 mo. After discharge while waiting to re-enter college, 6 mo with automotive parts supply company and automotive machine shop. Since graduation, 2 yr with large steel and related products manufacturer, in design and drafting on farm buildings and equipment. Married. Age 25. Slight service-connected disability to left hand. Available on reasonable notice. Salary open. W-97-329

**EXTENSION,** management, or research in soil and water field, in federal agency or with manufacturer or farming operation, preferably in the U. S. A. BS deg in agricultural engineering expected January 1950, University of Missouri. Farm background. Experience in library part time for 3 yr while in school. Summer of 1949, 2 mo full time in farm building work with private contractor. Married. Age 24. No disability. Available Feb. 1. Salary \$2900 min. W-161-330

**CUSTOMER BOOK**  
**BLOOD BROTHERS MACHINE CO.**  
 takes power around corners in agriculture



**Cross Power Corn Shellers Use**  
**BLOOD BROTHERS Universal Joints**

Corn shelling by power take-off is another of the many applications of Blood Brothers Universal Joints. Cross Power Corn Shellers are equipped with these famous Universal Joints for bigger-then-ever savings in set-up and operating costs. Blood Brothers have been supplying flexible power for farm equipment for over 35 years. This is your assurance that Blood Brothers can "take power around corners" for you — at maximum operating efficiency. Write for engineering data.



*Agricultural Universal Joints*

**BLOOD BROTHERS MACHINE CO.**

ALLEGAN, MICHIGAN • CHICAGO OFFICE 122 S. MICHIGAN AVE.

**DIVISION OF STANDARD STEEL SPRING CO.**

Supplying original manufacturers only, replacement parts should be ordered through him

# TIMKEN® BEARINGS HELP ALLIS-CHALMERS GET LONG GEAR LIFE IN MODEL "B" TRACTOR

## TRACTORS

### REAR AXLE DRIVE MOUNTED ON TIMKEN® BEARINGS

#### PROBLEM:

How to help obtain successful gear performance in a tractor rear axle drive.

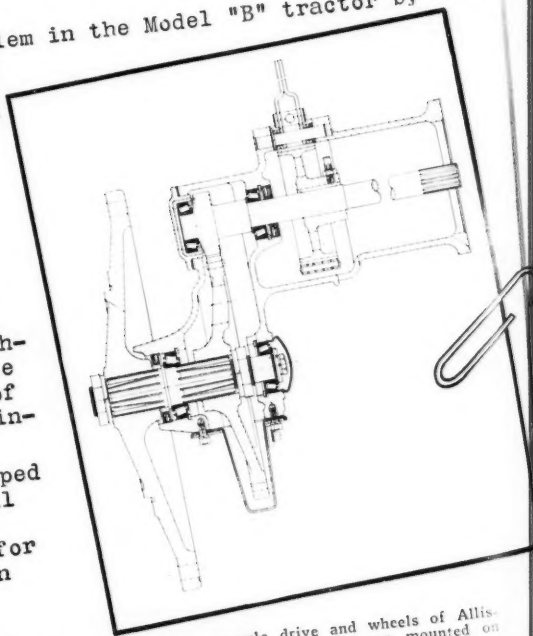
#### ANSWER:

Allis-Chalmers solved this problem in the Model "B" tractor by using a Timken bearing straddle mounting of the bull pinion. This mounting eliminated deflection in the shaft supporting the bull pinion, thus paving the way toward the use of narrow-faced gears without sacrificing performance.

Timken bearings are also used in the rear wheels where adjustment is obtained by means of shims. The simple, through-bored housing assures accurate and constant gear alignment of the bearings at minimum machining expense.

**CONCLUSION:** When farm machinery is equipped with Timken bearings, it will run smoother...longer...and sell better---good reasons for including Timken bearings in your next design.

THE TIMKEN ROLLER BEARING COMPANY  
Canton 6, Ohio - Cable Address "TIMROSCO"



How the rear axle drive and wheels of Allis-Chalmers Model "B" tractor are mounted on Timken bearings.



NOT JUST A BALL ○ NOT JUST A ROLLER □ THE TIMKEN TAPERED ROLLER □ BEARING TAKES RADIAL ○ AND THRUST —○— LOADS OR ANY COMBINATION □

